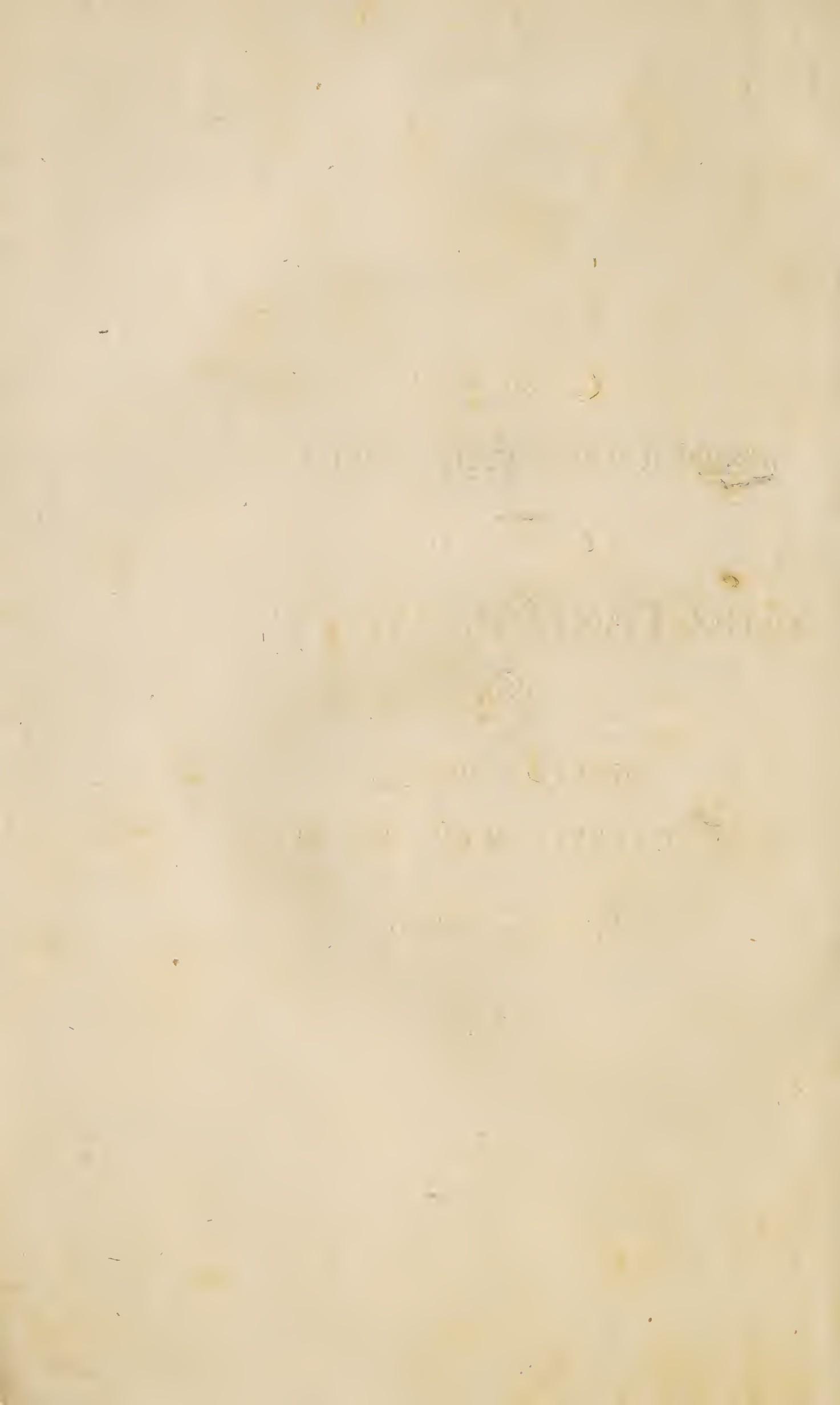


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A NEW
EXPERIMENTAL INQUIRY
CONCERNING THE
CHELTENHAM WATER,
&c.

THIRD EDITION,
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A N E W
EXPERIMENTAL INQUIRY
INTO THE
NATURE AND QUALITIES
OF THE
CHELTENHAM WATER.

TO WHICH ARE NOW ADDED,

O B S E R V A T I O N S
ON SUNDRY OTHER WATERS:

Shewing how their Properties may be ascertained, their Virtues
preserved, their Impurities corrected, &c.

WITH AN

A P P E N D I X
ON THE

MEPHITIC - ALKALINE WATER,

A NEW AND APPROVED
REMEDY AGAINST THE STONE AND GRAVEL.

By A. FOTHERGILL, M. D. F. R. S.
MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS,
AND OF THE MEDICAL SOCIETIES OF
LONDON, EDINBURGH, AND PARIS.

Intrandum est in rerum naturam, & penitus quid ea postulat, pervidendum.

Cic.

B A T H:

Printed by R. CRUTTWELL; and sold by W. TAYLOR, Church-street;
R. BALDWIN and J. JOHNSON, London;
T. HARWARD, Cheltenham and Gloucester, and all other Booksellers.



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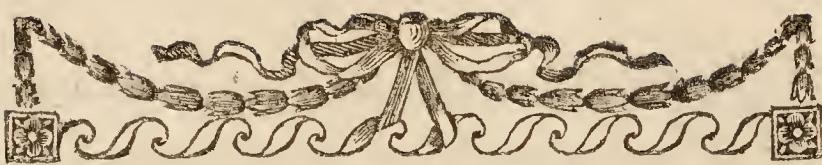
THE REV. JAMES STONHOUSE, M. D.
RECTOR OF GREAT AND LITTLE CHEVEREL, WILTS;
AND FORMERLY PHYSICIAN TO THE NORTHAMPTON
INFIRMARY:
WHOSE SKILL AND HUMANITY AS A PHYSICIAN,
WHOSE ZEAL AND ELOQUENCE AS A PREACHER,
AND WHOSE EXEMPLARY CONDUCT AS A DIVINE,
HAVE CONSPIRED TO RENDER HIM AN ORNAMENT TO
BOTH PROFESSIONS;
AND, WHAT IS YET MORE IMPORTANT,
THE FRIEND, AND BENEFACTOR OF MANKIND:

THE FOLLOWING INQUIRY,
AS A SINCERE, THOUGH INCONSIDERABLE TRIBUTE OF
GRATITUDE, AFFECTION, AND ESTEEM,
IS MOST RESPECTFULLY INSCRIBED,
BY HIS MOST OBLIGED FRIEND,
AND VERY HUMBLE SERVANT,

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P R E F A C E.

AS an acknowledgment for the very favourable reception which the former impression met with, the PUBLIC is here presented with the following IMPROVED EDITION. In order to render this more worthy their acceptance, the former (which had been long out of print, though repeatedly called for) has been revised throughout, and many of the experiments repeated.

As a further testimony of his respect, the Author now submits to their consideration some additional observations on OTHER WATERS, which (if he may be permitted to judge from the importance of the subject) will not be found wholly unworthy their attention.

COMMON WATER, being the basis or foundation of all the waters of our globe, was judged worthy to take the lead. The various impregnations, of which it occasionally partakes, naturally led to the consideration of the waters
of

of the Ocean, and Mineral Springs. As these, at present, administer so conspicuously to our health, convenience, and amusement, and are even thought worthy to constitute our most fashionable remedies, they could not, with any propriety, be passed over in silence.

The *Analysis of Waters* has always been deemed an object of importance, and, when it comes to be more cultivated, will doubtless be considered, by persons of a liberal education, as a branch of science not less useful than entertaining.

Philosophical chemistry, the foundation of this and almost every other useful science, has of late years received innumerable improvements, and is now rapidly advancing towards perfection, not only in England, but also in Germany, France, and Italy. To many of whose distinguished authors we are indebted for great and important discoveries, which cannot fail to immortalize their memories.

Among those of our own country, is it necessary to mention the names of BLACK, CULLEN, PRIESTLEY, CAVENDISH, KIRWAN, &c.? or abroad, need we enumerate those of BERGMAN, SHEELE, LAVOISIER, BERTHOLLET, ACHARD, &c.? Their ingenious publications

cations are far beyond my praise, but will speak their own eulogy to all succeeding generations. To all of them, I acknowledge my obligations, for the pleasure and instruction which their writings have afforded me. To the incomparable BERGMAN *first*, is the tribute of gratitude particularly due—and *next*, to some of our own illustrious countrymen.

Authors who formerly favoured the world with their Analyses of Mineral Waters, collected their solid contents with considerable exactness, and from thence *alone* they deduced their real or imaginary virtues. But they wholly neglected the volatile aerial parts which were suffered to escape during the process, though these confessedly constitute the most active ingredients in the composition.

Much however is due to their labour and industry, and even their errors claim our indulgence, considering the slow progress of science, when unenlightened by the rays of chemistry. It seems to have been reserved for the present age, to develope the mystery concerning the MINERAL SPIRIT of Waters, formerly considered as altogether *inscrutable*; and also to demonstrate, that many of the substances, which have appeared to be simple, are in reality compounds.

In a word :—The valuable discoveries concerning *aërial fluids*, and particularly fixed air, (which uniting with other bodies forms new compounds, possessed of their own peculiar properties) have already produced so considerable a revolution in former systems, as to constitute a new and important æra. As those lead to a more accurate knowledge of the constituent parts of natural bodies, so they cannot but materially influence the doctrine of Mineral Waters.

The increasing reputation of the CHELTENHAM SPA had indeed long attracted public attention, but surely its salubrious powers were never before exerted in so NOBLE a cause as that of the HEALTH of its SOVEREIGN. An attempt, therefore, towards an *improved Analysis* of the WATERS will not, it is hoped, at *this juncture* be thought UNSEASONABLE.

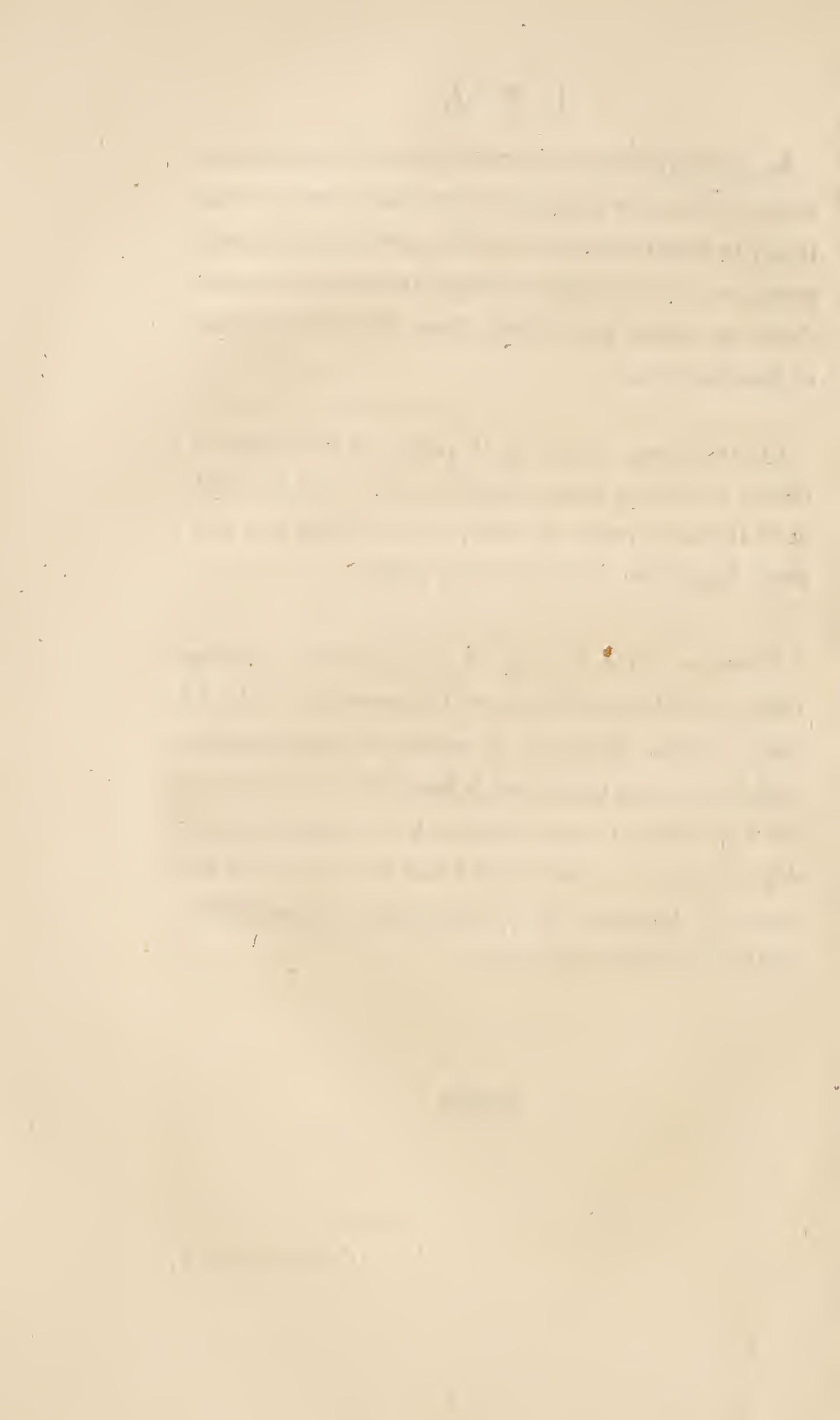
The following experiments, though chiefly intended as the amusement of a few leisure hours, were nevertheless carefully conducted, and the phenomena minutely noted down as they occurred, though without descending to unnecessary minuteness. A paper, containing the result, was afterwards communicated to some able judges, who deemed it not unworthy publication; otherwise, perhaps, it never would have ventured to have met the public eye.

Its Author, having no interest to serve either in depreciating the water, or exaggerating its virtues—no particular theory to support—nor any object in view—except that of truth, has often indeed been obliged to controvert certain doctrines which had hitherto been implicitly received as sacred oracles.

In attempting, however, to point out the errors of others, he is by no means forgetful of his own; but shall, at all times, be ready to rectify any oversight that may have escaped him in the following pages.

Conscious of the difficulty of the undertaking, and the fallacy to which experiments of this nature are liable, he claims further indulgence to render the present analysis complete. If, in the interim, it should tend but to advance the knowledge of waters in *general*, or contribute in any degree towards a more rational and successful use of this water in *particular*, his principal aim is accomplished, and his time fully compensated.







C O N T E N T S.

	Page.
PREFACE—containing some Account of the additional Articles in the present Edition—Improvements in Chemical Knowledge—transferred to the Analysis of Waters—applied to that of Cheltenham Water—whether an Element	vi I
— its Properties—Habitudes	— 7
— different Impregnations	— II
Mineral Waters	— 14
— their Contents—Hot Springs—whence	— 15
Analysis of Waters—its Importance	— 19
Sensible Qualities of Waters first to be observed—next by Chemical Tests	— 21
— by Evaporation—Crystallization	— 27
Criterion of the Analysis	— 28
Sea-Water—how rendered fresh	— 31
— its Contents—why different at different Depths	— 34
Hard Waters what—how corrected	— 37
Stagnant Waters how purified	— 41
The Filtering Stone when useful	— 43

Cheltenham,

<i>Cheltenham, its Situation</i>	—	—	45
<i>Improvements—Royal Visitors</i>	—	—	47
<i>Cheltenham Water—Sensible Qualities—Temperature</i>	—	—	
<i>—Specific Gravity</i>	—	—	48
<i>Habitudes with Precipitants</i>	—	—	49
<i>Volatile Parts, how obtained</i>	—	—	51
<i>Solid Contents obtained by Evaporation</i>	—	—	52
<i>Properties of its Salts</i>	—	—	53
<i>Of its Dry Residuum</i>	—	—	56
<i>— volatile Parts when lost whether recoverable</i>	—	—	57
<i>— Inferences from the Analysis</i>	—	—	58
<i>— Its Purging Salts—their Nature how distinguished</i>	—	—	65
<i>— Its solid Contents—their Nature</i>	—	—	68
<i>— Its Mineral Spirit—how preserved—or restored when lost</i>	—	—	70
<i>Cause of Decomposition in Bottles hermetically sealed</i>	—	—	72
<i>— Solid Contents in a Gallon</i>	—	—	73
<i>— Aërial Fluids in like quantity</i>	—	—	74
<i>— The medicinal Properties of each</i>	—	—	77
<i>Fixed Air—how distinguished from volatile Vitriolic Acid—its Energy in Mineral Waters</i>	—	—	83
<i>Hepatic Air—gives Sulphureous Quality</i>	—	—	84
<i>Cheltenham Water unfriendly to Vegetation—is diuretic or diaphoretic, according to Circumstances</i>	—	—	85
<i>— Its Operation in Diseases of the First Passages.</i>	—	—	
<i>— in those of the Lymphatic System</i>	—	—	86
<i>— whether explicable on Mechanical Principles</i>	—	—	98

— Three Classes of Diseases to which it is adapted	90
— wherein doubtful — — —	92
— Whether in Tuberclcs of the Lungs	93
— wherein improper — — —	94
<i>Directions for drinking the Water</i>	95
<i>Diet and Regimen adapted thereto</i>	101
<i>What Circumstances to be avoided</i>	102
<i>Analysis of other Mineral Waters recommended—Advantages that would thence result</i>	103

A P P E N D I X.

<i>Water, whether essential to Air</i>	107
— whether capable of Decomposition—whether its component Parts be yet known	108
<i>Cheltenham Water, how imitated by Art</i>	109
<i>Mephitic Alkaline Water—its Antiseptic Quality</i>	111
— its Efficacy against Stone and Gravel	112
— how best prepared	113
— whether it be not Diuretic	119
— a Deception concerning Soap Ley explained	120
— the Calculus—its Component Principles, and whether it can be decomposed	121



Quæ huic opusculo defunt, suppleat ætas.

QUINTIL.

A N E W
E X P E R I M E N T A L
I N Q U I R Y, &c.

W A T E R,

*Whether an Element—Its general Properties—and
Habitudes with other Bodies.*

WATER, when perfectly pure, is a simple fluid destitute of odour, taste, and colour. It enters the composition of all bodies, whether animal, vegetable, or mineral, except metals, and siliceous earths, and may be again obtained from them by distillation. Till lately, it has been allowed by philosophers to be one of the FOUR ELEMENTS; nay, some of them have gone so far as to maintain water *alone* to be the elementary matter, out of which, all things in the visible creation are formed, and into which, by chemistry, they may be re-converted.

From the experiments, however, of some of the most ingenious philosophers of the present day, it would appear that water is no longer to be considered as a simple element, but a compound body,

B

consisting

consisting of a certain portion of vital and inflammable air.*—“ That it is produced, not only by “ the explosion of these two airs by the electrical “ spark, but also by reviving mercury from red pre-“ cipitate in alkaline air. In this instance, say they, “ the precipitate supplies the vital, or dephlogisti-“ cated air; and the alkaline air, the phlogiston.” But is it not singular then, that no water is produced by reviving mercury from red precipitate?

Water, I conceive to be essential to the formation of inflammable air, because the latter cannot be produced from a solution of iron in the vitriolic acid, unless the acid be first considerably diluted with water. Now, admitting this, may not the water seemingly obtained from the combination of the two airs, proceed from a precipitation of that fluid from the inflammable air? or, in other words, may not the water thus procured be considered rather as a natural consequence of the *decomposition* of inflammable air, than a *real production* of water? In this light, it may not be amiss for the present to view this curious phenomenon, till the new doctrine be more fully illustrated by future experiments, though other arguments are not wanting which seem to prove water a real compound.

* See Cavendish's Experiments, Philosophical Transactions, vol. lxxiv. art. 13. Also M. Lavoisier's Observ. sur la Physique, tom. 23, p. 452.

Not only water, but even pure air, fire, and earth, have been pronounced, by modern chemists, **COMPOUND BODIES.** If this be true, the **ANCIENT ELEMENTS** no longer exist, and we may soon expect to see the famous *Berkleian* system re-established. When this happy period arrives, how pleasant will it be to behold its *ideal* supporters contemplating *ideal* bodies, amidst numerous *ideal* worlds—of their own creation! The phlogiston too has lately shared the same fate. This subtle principle, which was wont to be considered as one of the most powerful agents in nature, is now declared, by some of the Royal Academicians at Paris, to have no real existence. Though they have hitherto failed of entirely convincing us of its non-entity, they have nevertheless displayed no small share of ingenuity, and adroitness in explaining away this fugitive principle, and even in accounting for all the phenomena, without its aid.

Water is a *solid* body when Farenheit's thermometer stands below 32° ; and *fluid*, when the mercury rises above that point, as it more frequently does, in all temperate climates; hence water, by European philosophers, is defined a *fluid*. But whether fluidity be its *natural state*, or the effect of *violence*, may admit of controversy. For whenever the degree of heat necessary to keep it in fusion, is absent, it

instantly assumes a hard crystalline form, under the denomination of ice.

Though ice is commonly reputed *water* brought into a preternatural state by cold, yet with regard to the real nature of things, and setting aside our arbitrary ideas, it might as justly be said, that water is *ice* preternaturally thawed by heat.

The crystalline appearance of water, in form of ice, doubtless led Sir ISAAC NEWTON into the mistake of water being a real salt, without reflecting that it is not only destitute of the distinguishing marks of that class of bodies, but acts as their universal solvent, which it never could do were itself a salt. Besides, it not only dissolves gums, gelatinous substances, saponaceous matters, common air, and gas, but also unites readily with alcohol, and in a certain proportion even with æther and essential oils; properties inconsistent with those of any salt yet discovered. On perfect metals it has no effect, though it corrodes some other metallic substances in contact with the air. Is this occasioned by the aerial acid? Or is it not rather owing to the vital air of the atmosphere subtracting the phlogiston of the metal?

Water is a volatile body, and also soluble in air, as salt is in water, and hence it rises in the atmosphere in form of mist, or vapour; when condensed

it

it again descends in rain, hail, or snow, according to the temperature it meets with in the upper regions; but then it soon returns to its original state of water, without appearing to have undergone any sensible change.

At 112 degrees of heat, it boils, and assumes a highly elastic form, and is then incapable of any greater degree of heat in open vessels, though, confined in a perfectly close vessel, it may be rendered red hot. But in this process, as well as in fermentation, wherein it successively passes from a state of water to that of wine, and alcohol, and from thence to vinegar, it probably undergoes a remarkable *decomposition*; and if so, it confirms the idea of its being a compound: otherwise these wonderful changes, it is presumed, can never be satisfactorily explained, and the mystery of fermentation must ever remain altogether incomprehensible.

Water is the most subtle and penetrating of all bodies, fire *only* perhaps excepted. It easily pervades substances which are impervious to air, nay, it is said to be capable of being forced even through the pores of gold, so that the most solid bodies in nature, under certain circumstances, are found permeable to water. Whatsoever therefore may be its constituent parts, if water be really a compound, they must be *inconceivably* minute.

Water, considered by itself, and free from any heterogeneous mixture, is probably always of the same nature; but during its passage through various *strata*, it becomes impregnated with various substances, partly suspended in it, and partly united with it by chemical solution; hence no water is ever found upon the surface of the earth in a state of perfect purity. Nay, even rain, and snow water, though elaborated by the peculiar powers of nature from the most subtle vapours, with a degree of perfection inimitable by art, are nevertheless found variously contaminated, according to the state of the atmosphere and other circumstances.

The purest of all waters we can arrive at, is that distilled from snow carefully collected in some very high situation. By repeated distillations, the greatest part of the earth and other fæulencies may be separated from this, and this is what we must be contented to call *pure* water.

The specific gravity of pure water has been generally estimated at 850 times as heavy as air. But it is difficult to fix its specific gravity, in order to ascertain its degree of purity, because it seldom continues many minutes exactly of the same weight, by reason of the air and fire contained therein. Thus a piece of pure ice placed in a nice balance, never

never continues two moments in equilibrio. But this we may say in general, that pure water, according to the latest and most accurate experiments (the thermometer being at 50° , the barometer at $29\frac{3}{4}$) appeared to be only about 800 times as heavy as air.

Water perfectly dissolves all saline bodies, and even glass itself, when previously fused with an alkaline salt.

The quantities of saline substances that could be dissolved in a single ounce of pure water, with the heat of 50° of Fahrenheit's thermometer, were as follows:

	Grains.
Regenerated Tartar	470
Epsom Salt	324
Salt of Tartar	240
White Vitriol	210
Sal Gem	200
Salt of Soda, or marine alkali	200
Sal. Ammoniac	176
Marine Salt	170
Salt of Glauber	160
Vitriol of Copper	124
Vitriol of Iron	80
Salt of Nitre	60
	Vitriolated

				Grains.
Vitriolated Tartar	—	—	—	60
Sublimate Mercury	—	—	—	30
Borax	—	—	—	20
Alum	—	—	—	14
Salt of Amber	—	—	—	5
Arsenic	—	—	—	1
Cream of Tartar	—	—	—	3

Selenite, or Gypsum, requires at least 500 times its weight of water to dissolve it. Barytes, or *Terra pondrosa*, 900.

Though water is only capable of holding in solution a certain quantity of any given salt, to the point of saturation, yet the water essential to crystallization enables it afterwards to dissolve an additional quantity of other salts in succession, to a very large amount.

Thus four ounces of water already saturated with nitre, will dissolve of white vitriol, half an ounce; of common salt, 6 drams; of sal. ammoniac, 6 drams; of soluble tartar, half an ounce; and after all these, an entire ounce of sugar.—A curious phenomenon in chemistry! worthy the attention of the Philosopher, and particularly interesting to those who are concerned in pharmaceutical operations.

The uses of water are extremely important to mankind, in food, in medicine, and in divers arts and manufactures.

As a food, it appears, from many instances, that water alone is capable of sustaining human life a much longer time than could be well imagined. Water, as a common beverage with all kinds of aliment, affords the best and most universal diluent in the world. For this purpose, that which is purest, lightest, softest, and most transparent, is undoubtedly the best.

" As to the medicinal powers of pure water (says " an eminent writer*) that simple fluidity, the ab- " sence of every quality that can offend the tenderest " organ, miscibility with the animal juices, dispo- " sition to pass off by the cutaneous pores more " plentifully than by the kidneys, in consequence " of its total want of irritation, constitute the prin- " cipal part of its medical character.

To which we may add, that it is the most commodious medium for applying to the human body the powerful agents heat and cold; of which the one expands and relaxes, the other contracts, and constringes all the solid parts of the animal machine.

* The late Dr. LEWIS.

The learned HOFFMAN, and other respectable authors, have esteemed water almost an universal remedy. And it must be confessed, that in many acute diseases, where the intention is to extinguish febrile heat, cold water, in conjunction with cool air, far surpasses not only the noted Fever Powders, but other febrifuge *nostrums*, and when properly applied, and duly administered, probably stands unrivalled.

Convinced of this by long experience, the Italian Physicians scruple not to administer water made cold by ice, to the amount of 12 or 15 pints in a day, applying at the same time, cold water or snow, to several parts of the body. By this method, as appears from their writings, they have upwards of fifty years past, been in the habit of treating fevers, even the *small-pox*, and that with a surprising degree of success.* Whence it is evident they have long anticipated the boasted improvements of our modern inoculators, and have also carried the anti-phlogistic regimen to a much greater extent, even making all possible allowance for the difference between their climate and our own.

* See Commerc. Norimb. 1736. Hebd. 8. sect 2.

The different Matters with which Waters are generally impregnated.

THE various substances which occasionally are found united with water, and with each other, by diffusion, or by chemical solution, may be chiefly comprised under four classes, viz. The Aërial, Saline, Metallic, and Earthy.

The Aërial, are

Atmospheric air	
Vital Air	
Fixed Air	
Inflammable Air	
Hepatic Air	
Phlogisticated Air.	

The Saline, are

Vitriolic Acid	
Nitrous Acid	
Marine Acid	
Vegetable Alkali	
Mineral Alkali	
Volatile Alkali	
Hepar Sulphuris.	

The Metallic, are

Iron	
Copper	
Manganese	
Arsenic.	

The

The Earthy, are { Magnesia
 Pure calcareous Earth, or Lime
 Argillaceous Earth
 Barytes, or ponderous Earth
 Siliceous Earth.

From their combinations arise several compounds, or neutral salts, soluble in water. All those that have been yet discovered, it is presumed, are comprehended under the following heads:

Neutral Salts.

I. VITRIOLIC.

Vit. Acid with Mineral Alkali, yields Glauber's Salt
 _____ Vegetable Alkali—Vitriolated Tartar
 _____ Calcareous Earth—Selenite
 _____ Magnesia—Epsom Salt
 _____ Argillaceous Earth—Alum
 _____ Iron—Green Vitriol
 _____ Copper—Blue Vitriol
 _____ Zinc—White Vitriol.

II. NITROUS.

Nit. Acid with Mineral Alkali—Cubic Nitre
 _____ Vegetable Alkali—Common Nitre
 _____ Calcareous Earth—Calcareous Nitre
 _____ Magnesia—Nitrated Magnesia.

III. MARINE.

III. MARINE.

- Marine Acid with Mineral Alkali—Common Salt
 ————— Vegetable Alkali—Digestive Salt
 ————— Calcareous Earth—Salited Lime
 ————— Magnesia—Salited Magnesia.

IV. AERIAL.

- Aërial Acid with Mineral Alkali
 ————— Vegetable Alkali
 ————— Pure Calcareous Earth or Lime
 ————— Pure Magnesia
 ————— Iron*
 ————— Zinc
 ————— Manganese. All which afford
 Aërated Compounds, more or less soluble in water,
 and therefore partaking of the nature of neutral
 salts.

Besides these, sometimes are found sulphur, fossil oil, and extracts from vegetable and animal substances. The foregoing heterogeneous matters are never found all together, but are more or less numerous in different waters.

SNOW WATER, though destitute of air, contains a minute portion of nitrous acid, and salited calcareous earth.

* Iron is sometimes suspended in waters by hepatic air:

RAIN WATER, besides the above impregnation, contains a variety of heterogeneous matters, which float in the atmosphere, and therefore never can be obtained pure, except after long-continued rain or snow, or on the tops of mountains remote from cities.

SPRING WATER. The waters of springs, wells, rivers, lakes, and marshes, contain more or less atmospheric and fixed air, fossil alkali, calcareous or argillaceous earths, combined with the aërial, vitriolic, nitrous, or marine acid; together with animal, or vegetable mucilage.

Next to snow water, the waters of certain springs and rivers, which flow rapidly over smooth pebbles, or bright sand, are the purest, and consequently best for internal use; those of marshes the least so.

Mineral Waters.

Mineral Waters are impregnated with saline, metallic, or other matters already mentioned, in quantity sufficient to affect the taste, and to exert medicinal powers different from those of common water. Some medicinal springs are hot, but the far greater number cold, or nearly of the same temperature with common springs similarly exposed.

The

The hot springs may probably derive their heat from subterraneous fire, as sometimes actually happens in the neighbourhood of volcanos, but perhaps much oftener from the decomposition of martial pyrites, or other sulphureous ores brought into contact with *vital air*. Fossil coal, and a variety of mineral substances, afford a constant supply of inflammable air in the bowels of the earth, but no sensible heat is produced, till *pure* air is admitted from the atmosphere. This, preferring the inflammable principle to every other body, rushes into union with it, when *actual* heat is instantly generated; proceeding, according to circumstances, in form of a smothering heat, a slow lambent flame, or bursting out into violent combustion, accompanied with tremendous explosions.

Thus, it is easy to conceive, how huge beds of earth and mineral strata may be kept continually hot, and constantly communicating their heat, together with their mineral effluvia, to the water, as it oozes through their pores, or flows through their subterraneous channels. Admitting the cause just assigned to be adequate to the effect, and consonant to the laws of nature, may it not assist us in adjusting the famous controversy so long agitated among philosophers, concerning the origin of hot springs; and at the same time reflect considerable

considerable light on the no less mysterious nature of volcanos and earthquakes?

Next, it may not be improper to attempt some explanation of the ingredients with which medicinal waters are generally impregnated, and the combinations which they form in consequence of mutual attraction.

AERIAL FLUIDS, generally abound both in hot and cold mineral waters, partly combined with the water, and partly with alkalis, earths, or metallic substances.

ACIDS, are sometimes discoverable in an uncombined state, but most frequently united to alkalis, earths, or metals.

ALKALIS, are sometimes found disengaged, but generally in union with the aërial or other acids.

LIME, and MAGNESIA, frequently occur, combined with the aërial, the vitriolic, nitrous, or marine acid.

TERRA PONDEROSA, and MANGANESE, are sometimes accidentally found united with marine acid.

ARGILLACEOUS

ARGILLACEOUS EARTH, or CLAY, is sometimes found in union with vitriolic acid, in form of alum; it has lately been discovered in the Nevil Holt water, joined to the marine acid, in form of salited clay.—A rare instance.

IRON, of all the metals, is most frequently discovered in mineral waters, and is held in solution commonly by the aërial or vitriolic acid;—sometimes, perhaps, by the marine.

COPPER, has only been found with the vitriolic, in form of blue vitriol.

ARSENIC, being extremely difficult of solution, has, fortunately for mankind, very rarely, if ever, been found in mineral waters. How far the poisonous effects of the celebrated Lake Asphaltites may justify the opinion, I shall not presume to determine; but certainly neither brimstone, nor bitumen, with which it is supposed strongly impregnated, can render it so deleterious; and were arsenic present in the water, the sulphur would strongly counteract its poisonous effects, by changing it into orpiment.

SULPHUR is discovered in certain mineral waters generally in form of hepatic gas or air; sometimes dissolved, by its union with alkali, or lime. In this

state it may possibly exist in form of genuine hepar, as in the noted sulphureous water of Aix-la-Chapelle, and other hot springs, where real sulphur has been found sublimed, and adhering to the surrounding walls.

Analysis of Waters.

When we consider the variety of foreign matters with which even our common springs are impregnated, and that some of these matters, though small in quantity, yet by being daily accumulated in the system, may at length prove the unsuspected cause of obstinate chronic diseases; it certainly concerns us to inquire diligently into the nature of the fluid which necessarily constitutes so considerable a share of our daily sustenance. More forcibly still ought this caution to strike us, when applied to medicinal waters, more strongly impregnated, and abounding with far more active principles.

" An accurate analysis of waters, (says the incomparable BERGMAN) is justly considered as one of the most difficult problems in chemistry; nevertheless it is highly necessary, not only as an interesting branch of natural philosophy, but as subservient both to public and private advantage." From thence we are enabled,

1st. To choose the purest common water for internal use.

2^d. To avoid such as is either unfit or noxious.

3^d. To form a proper judgment concerning medicinal waters. Thus, if long experience has shewn the efficacy of a certain spring, the contents of which are well known, we may instantly form a judgment concerning others whose contents exactly resemble it, and thence be enabled to anticipate the experience of years.

4th. To select such waters as are best adapted to the several arts and manufactures, without which they never can be carried on with advantage.

5th. To correct impure or vitiated water, or to separate from it extraneous substances, with which it is contaminated, or rendered pernicious.

6th. To imitate such waters as are justly celebrated for extraordinary virtues, if a sufficient quantity of the natural water cannot be conveniently obtained.

Sensible Qualities to be observed.

Previous to the chemical examination, the sensible qualities of the water ought to be carefully attended to. Such are the taste, smell, colour, and

degree of transparency. These, together with its specific gravity, temperature, and nature of the surrounding soil, to a nice observer, will afford considerable information.

Thus with respect to *Taste*, the aërial acid gives a gentle smartness or poignancy;—vitriolic or nitrous salts, a bitterness;—lime or selenite, a slight austerity;—alum, a sweetish astringency;—mineral alkali, and marine salt, a nauseous brackishness;—copper, a slight taste of brass;—iron, an inky taste.

As to *Smell*, aërial acid diffuses an agreeable penetrating odour like that of fermenting liquors;—hepatic air, an odour like that of a foul gun, or ignited gunpowder;—stagnant and corrupted waters emit a putrid offensive smell.

Respecting *Colour*. Though good water is entirely without colour, yet colourless water is not always good. A brown, reddish, or yellow colour, betrays several animal, vegetable, or mineral impurities;—a blue indicates vitriol of copper;—a green, or variegated film, vitriol of iron;—and a yellow ochrey sediment, puts this matter beyond a doubt.

Transparency. A crystal clearness indicates great purity, though very hard waters sometimes assume

assume this appearance. When the bottom is clay or mud, the water is never clear, but assumes a milkiness or opacity which obstructs the rays of light from passing through it.

Lightness, in the hydrostatic balance, in general affords a favourable sign of purity, especially if there be found no earthy or ochry sediment, no saline efflorescence in its neighbourhood, nor animalculæ in the water.

By Chemical Tests or Precipitants.

The various impregnations are detected by certain chemical tests, called *Precipitants*.

AERIAL FLUIDS may be separated, and collected by boiling the water in a glass retort with a long neck, bended upwards into the mouth of a receiver inverted in mercury, as described by BERGMAN.* If this apparatus be wanting, a simple Florence flask, with a bladder, may answer the same intention, if properly managed. The elastic fluid thus collected, consists chiefly of a mixture of common air, and aërial acid.

* See Chemical Essays, vol. i. p. 143, with a suitable drawing of the apparatus annexed.

To determine the quantity of each, one of them must be separated.—This is performed by agitating the aërial fluids in a vessel filled with lime-water. This will entirely absorb the aërial acid, and leave the common air alone, the bulk of which subtracted from the whole, shews the quantity of aërial acid. The quantity and quality of the residue may afterwards be ascertained.

COMMON AIR, and VITAL AIR, are distinguished by supporting flame.

AERIAL ACID, and PHLOGISTICATED AIR,—by extinguishing flame, precipitating lime-water, and by changing the blue colour of litmus, red.

HEPATIC AIR, or SULPHUREOUS GAS,—by a fetid sulphureous odour; by rendering white arsenic yellow, when immersed in the water.

ACIDS,—by changing syrup of violets, and other vegetable blues, to a red colour.

ALKALIS,—by changing them to a green, and by precipitating a solution of salited lime in form of clouds, when dropt into the water; by changing tincture of Brazil wood *blue*; turmeric, *brown*; and solution of corrosive sublimate, *yellow*.

VITRIOLIC

VITRIOLIC SALTS,—as *Glauber*, *Epsom*, *Blue Vitriol*, *Green Vitriol*,—by a solution of *Terra Ponderosa* in marine acid, otherwise termed *Barytes Salita*; a single drop of which detects the smallest vestige of vitriolic acid, in whichever of these forms it exists, by instantly producing white streaks, or cloudiness.

NITROUS SALTS,—as *Common Nitre*, and *Nitrated Lime*,—by *Solution of Silver in Nitrous Acid*, which dropt into the water produces a striated whitish cloud:—By exposing the residuum after evaporation to *ignited iron*, when a hissing or crackling noise will be perceived if nitre be present.

MARINE SALTS,—as *Common Salt*, *Salited Lime*, *Salited Magnesia*,—by *Solution of Silver in Nitrous Acid*, which renders the water turbid; and as the marine acid quits every other basis to unite with silver, precipitates it in form of *luna cornea*:—By *sugar of lead*, which yields clouds, and a white precipitate.

EARTHY BODIES,—as *Lime*, *Chalk*, *Selenite*, *Magnesia*, *Clay*, *Alum*,—by *Solution of Fixed Alkali*,* producing

* Except *Terra Ponderosa*, which resists this precipitant; but should it be present, it may easily be detected by vitriolic acid, which converts it into a ponderous spar, and precipitates it in an insoluble form.

ducing clouds and precipitation:—By *Acid of Sugar*, which produces instantly white streaks or clouds, if but a single grain of lime or pure calcareous earth be contained in three pints of the water:†—By a *Solution of Soap in Spirit of Wine*, which instantly renders the water turbid.

METALLIC BODIES combined with Acids,—by *Phlogisticated Alkali*, which precipitates all metallic salts, but leaves those with an alkaline or earthy base untouched; hence, on adding it to any water, it soon discovers by precipitation, whether it contains any metal.

IRON,—as *Vitriol of Iron, Aërated Iron*,—by *Tincture of Galls*, which strikes a dark blue inclining to black, if the iron be vitriolated; purple, if aërated, or suspended by fixed air:—By *Phlogisticated Alkali*, which, with iron, yields a beautiful Prussian blue.

COPPER,—*Vitriolated, Aërated*—by *Volatile Alkali*, which, dropt into the water, yields a blue:—By *Phlogisticated Alkali*, which gives a reddish brown:—By *polished iron*, immersed in the water, assuming a copper colour.

† Essential Salt of Sorrel yields the same appearances, though in a smaller degree.

ZINC,—*Vitriolated*, or *White Vitriol*,—by *Phlogisticated Alkali*, which yields a white precipitate, which preserves its colour even under calcination.

MANGANESE,—*Salited*,—by *Phlogisticated Alkali*, which also affords a white precipitate, but which grows black by calcination.

ARSENIC,—*Calciform*,—by casting the residuum after evaporation, on red-hot iron, when the arsenic, if any be present, will emit an odour like that of garlic.

SULPHUR,—as *Hepar Sulphuris*, with *Alkali*,—with *Lime*,—by fetid odour, like that of a foul gun:—By turning white arsenic yellow, and converting it into orpiment:—By rendering silver black:—By *concentrated acids*, which render the water milky, and precipitate the sulphur yellow, when united with alkali; white, when with quick lime; and black, with a solution of lead in nitrous acid.

ANIMAL OR VEGETABLE MATTER,—by *Solution of Mercury in Nitrous Acid*, termed *Nitrated Mercury*, which dropped into the water impregnated by mucilaginous matters, produces white streaks or clouds, followed by a precipitation.

Solid

Solid Contents obtained by Evaporation—Crystallization—Chemical Attraction.

The nature of the volatile, and other ingredients being thus examined by the most approved chemical tests hitherto discovered, we next proceed to collect the solid contents for further examination. But they must be first separated by a long and diligent process, before their respective qualities and proportions can be accurately ascertained. A gallon of the water being slowly evaporated in a proper glass, or earthen vessel, the earthy and saline matters appear in succession according to their degree of solubility—the least soluble first—thus lime and acrated iron take the lead, followed by alum, martial vitriol, nitre, vitriol of copper, mineral alkali, marine salt, Epsom salt, and lastly, the deliquescent salts. The evaporation being gradually continued to dryness, the entire residuum is to be digested in spirit of wine, and the liquor filtered. This second residuum next, in eight times its quantity of cold distilled water, and filtered. Finally, the third residuum to be boiled in 500 times its weight of distilled water, and afterwards filtered. The remaining residuum is now no longer soluble either in spirit of wine, or water. If iron be present, distinguishable by its *rusty* colour, let the residuum be exposed to the rays of the sun for

for three weeks, and moistened from time to time; by which it will be so much *dephlogisticated* as to be insoluble in vinegar, and its weight may then be ascertained, with tolerable exactness.

The matter dissolved in spirit of wine, is lime, or magnesia united with nitrous or marine acid, both which salts may be decomposed by diluted vitriolic acid. If it be lime, *selenite* will precipitate; if magnesia, *Epsom salt* will be obtained by evaporation.

The salts dissolved in the cold water, may be separately obtained by crystallization. They may be alkaline, earthy, or metallic. Alkaline salt is known by its *lixivious* taste, and *effervescing* with acids; and, whether vegetable or mineral, may be determined by distilled vinegar, which with the former yields a *deliquescent* salt; with the latter, *foliated* crystals.

Neutral salts, composed of vitriolic acid, and any basis whatsoever, may be decomposed by *Barytes Salita*; if of nitrous acid, the vitriolic will expel it, and the fume will be *red*; if of marine acid, *grey*.

The species of neutral salt may be generally distinguished by the *figure* of the crystals. If the acid

acid be *vitriolic*, it may be doubtful whether the basis be *mineral alkali*, or *magnesia*; that is to say, whether it be a *true* or *spurious* glauber salt, from the similarity of their crystals. If it be the former, and a bit of the salt be immersed in lime water, the solution retains its *transparency*; if the latter, it instantly exhibits whitish *clouds*. If the acid be the *marine*, the species of alkali may be discovered by adding the acid of tartar to a solution of the salt; if it be the *vegetable alkali*, a genuine *tartar* will be precipitated; if *mineral alkali*, no *decomposition* will ensue. If the basis of the marine acid be *calcareous earth*, the vitriolic acid will decompose it, and form *selenite*. If *magnesia*, *Epsom salt*; if *clay*, *alum* will be produced. If *copper* be the basis, volatile alkali will render the solution *blue*; if *iron*, tincture of galls will turn it *purple* or *black*.

The residuum of the solution made by boiling water consists of *selenite* only, which may be either separated by *crystallization*, or decomposed by a *fixt alkali*.

Criterion, by which the justness and accuracy of the whole process may be determined.

After the several ingredients have been carefully examined, and their respective proportions determined by weight, or measure, it will be yet further necessary

necessary, for general satisfaction, first to reduce the sundry articles, as near as may be, to their pristine state, and then to recombine the whole with a due proportion of *pure* water, properly impregnated with fixed air.

If the water should at length be found, after a second, or even third repetition of the process, exactly similar, in all its distinguishing properties, to that of the springs from whence it was taken, there certainly needs no further proof of the justness of the analysis, or of the importance of the improvements, which this branch of philosophy has lately acquired.

Though few mineral waters can either demand or deserve a repetition of such a critical examination—yet the dignity of the ART, and the striking imperfections of former publications, (not to mention the unmerited derision, with which their authors have been treated) require that nothing essential towards a *new* and *improved* analysis should be overlooked. In the interim, the present hasty sketch is chiefly meant to stimulate others, more competent to the task, to supply what, through brevity, has been here omitted, and likewise such further additions as may seem to be wanting, towards the completion of so necessary and important an undertaking.

Methods by which Salt Water may be sweetened—Hard Water, corrected—Corrupt Water, purified.

To render sea-water fit for mariners in long voyages, is an object of the highest moment. It has long excited the attention of chemists, and also of the British Parliament, and for which the latter have awarded very liberal premiums. Various methods have been proposed, but that by simple distillation of sea-water *alone* has at length been found sufficient, and has attained a great degree of perfection, both in France and England.

Dr. IRVING, by a very simple contrivance, for which he obtained a parliamentary reward of 5000l. presents us with the following improvement:—To the lid of the common kettle for boiling provisions aboard a ship, he has adapted a metallic tube. The fresh vapour which arises from boiling sea-water, passes through this tube into a hogshead, which serves as a receiver. In order to condense the vapour, the tube is kept cool, by constantly mopping it with cold sea-water. It appears, that 80 gallons of sea-water, by this method, yielded 25 gallons per hour of fresh water, well tasted, and of less specific gravity than the best spring water in that neighbourhood. The officers, who were present, concluded that 500 gallons of fresh water might thus

thus be obtained with the same quantity of fuel, in proportion to the time, as is required in the ordinary business of the ship. As the ship's kettle is divided in the middle by a partition, one of these parts being only in use at certain times, the other contains water to preserve its bottom. Dr. IRVING has availed himself of this circumstance, and by filling the spare part of the copper with sea-water, and fitting on the tube, draws off 60 gallons of fresh water during the boiling of the provisions, without loss of time, or any additional fuel.*

It has been long known, though lately announced as a new discovery, that by *freezing*, the ice of sea-water is divested of its saltiness, and when thawed, yields *fresh* water. For BARTHOLIN, in his work concerning the use of snow, (published many years ago) relates this circumstance, which soon became a matter of such public notoriety, that the thawed ice of sea-water was afterwards used at Amsterdam for brewing.

Captain COOK, in a late voyage round the world, was fortunately supplied with fresh water from melting the ice found floating in the sea; and this water, our celebrated circumnavigator assures us, was not only fresh, but soft and *wholsome*.

* See Voyage towards the North Pole, Appendix, p. 205.

This may prove an useful hint to those who undertake long voyages towards either of the poles, especially when they begin to experience a scarcity of fresh water amidst frozen seas. But whether fresh water be thus obtained from dissolved ice of sea, fresh river water, or by a distillation of sea-water, it is quite destitute of air, and in an unnatural state; and therefore, notwithstanding the opinion of the great voyager, may be presumed not very *wholesome*. This, however, may be remedied, by exposing the water for some time in open vessels, that it may imbibe its proper quantity of air from the atmosphere. Or what, I conceive, would be an additional improvement, it might be impregnated with the aërial acid, by a suitable contrivance, as lately invented by the ingenious Mr. HENRY of Manchester, for impregnating the water of a ship. This would impart to the water the briskness of fresh spring water, and at the same time render it a preservative, perhaps a *remedy*, against the ravages of the scurvy, and putrid fevers, especially as the antiseptic virtues of the aërial acid, are now generally acknowledged. To this acid, chiefly, are the antiseptic and antiscorbutic effects of cyder, perry, and spruce-beer, to be attributed.

Sea-water, at present, being so fashionable a remedy amongst the superior, and middle ranks of society,

society, and especially among those individuals who revolt at the very idea of being thought *unfashionable*: It may not be amiss to inform them, that this nauseous potion, indiscriminately taken, is by no means a matter of indifference; and that the abuse of sea-water and sea-bathing, however *fashionable*, may, nevertheless, sometimes prove highly detrimental. Moreover, that the peculiar sickness produced by sea-water, accompanied with enormous vomiting, proceeds from the acrimony and bitterness of the marine magnesia, and putrid animal substances, which *particularly* abound near the surface.—And finally, that these nauseous ingredients are not to be found at all, or but very little, in sea-water taken up at the *depth* of 60 fathom; as appears evident from the experiments of that accurate chemist Sir T. BERGMAN. Here the water, he informs us, had no bad smell; the taste, though intensely salt, was by *no* means nauseous, like that which was got at the surface.

The reason of this difference, probably is, that the immense quantity of fish, and other animals which die in the ocean, are gradually carried up to the surface, and there, by the assistance of the air, are destroyed by putrefaction, which process is greatly assisted by the salt which at the surface is present precisely in the quantity, necessary to promote that operation.

On analysing the water taken up at the above depth, he obtained, from a measure containing about three English pints,

	Ounces.	Grains.
Of common salt	— 2	433
Marine magnesia	— 0	380
Selenite — —	— 0	45*

Sea-water has been generally observed to contain more common salt in *hot*, than in *cold* climates, and the quantity to vary in different seas, according to the greater or less evaporation, or accession of fresh water, from about $\frac{1}{5}$ to $\frac{1}{2}$ th of the weight of the water. Thus the Baltic sea is very weakly impregnated; the English, and German, more strongly; the Mediterranean, still more; and the Mosambique much salter even than this.†

The saline ingredients are found in different quantities and proportions, but the quantity of *common salt* is always greater than that of any other, amounting on an average, to the proportion of water, as 3, or 4, to 100; so that the strongest sea-water is far below the point of saturation; water being capable of dissolving nearly a fourth part of its weight of common salt.

* BERGMAN'S Chem. Ess. v. i. p. 230.

† Mem. de l' Acad. Par. 1711.

Count MARSIGLI, after a long course of experiments, concludes, that in order to shew the different nature of sea-water, in various places, three liquors *alone* are necessary to be carried abroad as very sufficient for that purpose, viz.

1. A strong infusion, or tincture of mallow flowers,
2. Spirit of sal ammoniac,
3. Oil of tartar per deliquum.

The first communicates to sea-water a greenish yellow; the spirit of sal ammoniac renders it turbid, and produces a slow precipitation; oil of tartar occasions the same change, but far more suddenly. By attentively marking these changes, and tinges of colour, and noting the quantity of matter precipitated, he was enabled (as he imagined) to ascertain the strength of the impregnation of sea-water, taken up at different places, and at various depths, and also to determine the purity of sea-water distilled, or sweetened by other methods. On pure distilled water, no change was produced; the less pure, the more visible the changes of colour, and quantity of precipitate.

Three yet more *exquisite* tests of the presence of marine salts with alkaline or earthy bases might, however, have been added by the noble Count; such are, I presume, with deference to his superior

judgment—a solution of *silver* in the *nitrous acid*—*Barytes Salita*—and *acid of sugar*. The first detects the smallest vestige of *marine acid*; the second, of *vitriolic*; and the third, of *earth, or lime*; and are so far likewise applicable towards ascertaining these principles in *all other waters*, and that with superior accuracy; though still by no means sufficient, like those of Count MARSIGLI, to supersede the use of *all other precipitants*.

For the waters of the ocean may be considered as containing a general assemblage of almost all the bodies in nature, that are either capable of being suspended or dissolved in an aqueous menstruum.

As the impregnation has been found to differ so widely in different places, and at different depths, there must be many other substances contained in it, besides those obtained by BERGMAN from a purer kind of sea-water, taken up at 60 fathom. Both the superior and inferior strata, comprehending a vast body of water, remain yet to be further explored.

The aërial and sulphureous qualities, together with the impregnations arising from the exuviae of decayed animal and vegetable productions, must therefore be referred to those who may incline to favour the learned world with (what is much wanted) an IMPROVED ANALYSIS of sea-water.

Hard Waters.

Waters termed *hard*, are distinguished by curdling soap, and by depositing a hard earthy incrustation on the bottoms of tea-kettles, and other vessels in which they are boiled; and yet such are many of our most noted springs. Hence those waters which are generally extolled for their great purity, are commonly, of all others, the *least pure*.

Though perfectly clear and transparent to the eye, and grateful to the palate, they are nevertheless (however paradoxical it may appear) extremely hard, and consequently impure. It is certain that such waters, when brought to the test, are generally found highly impregnated with calcareous spar, or gypsum, often to the amount of an hundred grains or upwards in a gallon.

There are other hard waters, which are not only impure, but extremely unpalatable, having an austere, bitter, or aluminous taste, which render them improper for internal use.

Hard waters, in general, are found unfit for bleaching, washing, boiling leguminous vegetables, and many other purposes of œconomy and arts.

The hardness of waters has been attributed, by some writers, to common salt; but Dr. HOME, in his experiments on bleaching, has shewn that neither common salt when pure, nor any other salt with an alkaline basis, can produce this effect. The salt which is in common use may indeed seem to afford an exception, as it contains a portion of absorbent earth, and is by no means pure.

The aërial acid, separate, or combined with earth or iron, is one cause of the hardness of waters; but this is easily remedied by boiling, or even exposing the water some time in open vessels, by which means this subtil gas exhales. The earth, or iron, which had been suspended by it, being now no longer soluble in the water, are precipitated, and the water is immediately rendered soft.

Whenever the aërial acid escapes, the bond of union is destroyed, and the earthy matters attach themselves firmly to the substances they happen to meet with. Hence it is that tea-kettles are so frequently covered with an earthy crust. Hence too, the ochrey sediment of chalybeate springs exposed to the open air.

Thus, mineral waters, weakly impregnated, might, by mere boiling and cooling, (if other water should

should be scarce) still be rendered useful for domestic purposes.

If the calcareous earth be united with the vitriolic acid in form of selenite, as most commonly happens, or even with the nitrous or marine acid, *this species* of hardness cannot be corrected by boiling alone, but may be accomplished by a *fixed alkali*; because alkalis prefer acids to earths, and therefore precipitate their earthy basis.

Thus also hard waters decompose soap; the acid of selenite, uniting with the alkali of the soap, leaves the oil and calcareous earth in a state of insolubility.

Water containing selenite instantly becomes turbid by the addition of a few drops of solution of silver, or of mercury in the nitrous acid. Here a double attraction takes place; the silver quits the nitrous, to unite with the vitriolic acid, while the calcareous earth quits the vitriolic acid to unite with the nitrous.

In order therefore to correct the hardness proceeding from selenitic salts, let a solution of pot-ash, or any fixed alkali, be added to the water, so long as it produces any turbidness. When no more is found to fall, the decomposition is effected, and the earth

earth entirely deposited. It is easy to determine, by weighing the solution of the alkali previous to the experiment, what proportion of alkaline salt any given quantity of the water requires.

The water thus corrected, must be decanted off from the sediment, and though in reality no purer than before, is found perfectly soft for œconomical uses, and much less (if at all) detrimental to health; its austere earthy salt being now converted into a mild neutral—the vitriolate tartar.

Stagnant Impure Waters.

Waters impregnated with mud, clay, or putrid animal and vegetable matters, are generally turbid, unpalatable, and often highly offensive. Such waters abound in low marshy countries, and are found extremely unwholesome, particularly in hot climates; where, in consequence of the immense evaporation which takes place, the muddy bottoms of lakes and ditches, replete with myriads of insects and their ova, are exposed to a vertical sun, exhaling a putrid stench, by which the superincumbent atmosphere is extremely contaminated. To this cause chiefly may be attributed the frequency of putrid and pestilential fevers, which, at certain seasons, infest these countries, and depopulate whole districts.

To

To render these waters fit for internal use, the inhabitants have recourse to the *filtering stone*, formed into a sort of mortar of a spongy texture. The water being poured into this, soon makes its way through, and is received into a vessel placed below for that purpose.

The Japanese place the utmost confidence in this filtering stone, and attribute their uninterrupted health, and freedom from gout, stone, and gravel, to their drinking the water, thus cleared of all its heterogeneous and mischievous particles. The people of that, and many other adjacent countries, have a settled opinion that these, and most other diseases, arise from the impurities of water; and are well assured that these impurities are thus completely separated by being all safely *lodged* in the filtering stone:—glad tidings for gouty and gravelly invalids! who certainly can have no reasonable objection to provide themselves with all convenient expedition, each man, with a suitable filtering stone. The price of these inestimable stones, doubtless, will immediately rise, at least 50, if not 100 per cent. But then, what joy and triumph will it not afford, thus at once to be able to deposit their gout, and stone, and bid a final adieu to their nurses, crutches, flannels, and other disagreeable accoutrements! What unspeakable pleasure to triumph over

over their doctors, and apothecaries—to rally them on their ignorance, and finally, set them ever after at defiance!

The matter, it must be confessed, appears sufficiently interesting; but if our venerable invalids will condescend, for a few moments, to suspend their triumph, and only put on their spectacles and sift the affair more closely, they will, it is to be feared, find no great cause for exultation. Should they happen to have a moderate share of knowledge in chemistry, they will soon begin to suspect there may possibly be some fallacy, and in further prosecution of the inquiry, they will be convinced of it; and finally will be obliged to conclude, with grief and astonishment, that the morbid particles of gout and stone are too subtle to be thus caught, and rendered for ever inactive, by this mode of imprisonment.

But to be serious.—Foreign matters suspended by way of *diffusion*, it is true, may be intercepted by filtration alone. While those which are combined in the way of *solution* are incapable of being thus separated. Such are, unfortunately, the earthy compounds which are supposed to constitute the morbid particles now under consideration; viz. Selenitic salts, and calcareous spars, which are so intimately combined with the water, as to readily pass

pass through the filter along with it. So strict is the union, that instead of rendering the water *turbid*, they heighten its *transparency*, which, by the way, may serve to explain the *crystalline* brightness of certain springs, remarkable for their hardness.

Whence it appears, that the Japanese have been rather too hasty in their conclusions concerning the effects of the filtering stone, and too sanguine in attributing to it their exemption from the above maladies, so prevalent among Europeans who neglect it; — a remarkable circumstance indeed, but which perhaps may be explained on other principles.

The filtering stone, though neglected in this country, is nevertheless an excellent contrivance, and applicable to various purposes, where a paper filter would be entirely useless. Thus, where the earthy substances in waters have already been decomposed by suitable precipitants, the filtering stone seems particularly adapted for separating the terrene matters precipitated, which, by decantation *alone*, can seldom be easily effected.

Impure waters may, by means of the filtering stone, be sufficiently cleared from living animalculæ, mud, clay, or other matters mechanically suspended in them; but when they are contaminated

nated by marine salts, or putrid substances *dissolved* in them, it seems requisite that they should undergo *distillation*,* or at least a *boiling* heat; and afterwards be exposed two or three days, in open vessels, to the *solar* and *atmospheric* influence.

It appears, from the experiments of Doctor INGENHOUZE, and others, and here seems particularly worthy of notice, that *pure* vital air is copiously generated in water exposed to the sun-beams, which water, deprived of the influence of light, yields only *noxious* or contaminated air.

It was first discovered by Dr. HALES, that impure or corrupted water may be sweetened by brisk agitation, or by merely passing a strong current of air, through it, as it is poured from one vessel to another.

By any of the preceding methods then, might also rain water, or the water of ships, pools, or cisterns, (rendered impure or even offensive by stagnation) be undoubtedly meliorated, if not perfectly restored.

* The process of distillation, though an effectual method, is too tedious to be often employed, except in cases of extreme necessity, as at sea.



CHELTENHAM WATER.

Situation of Cheltenham—its Improvements—increasing Reputation of its Mineral Spring—now termed ROYAL SPA.

CHELTENHAM is a market-town in Gloucestershire, near a mile long, situated in a sandy vale, partly environed by high rocks and hills. The air is esteemed very pure, and the adjacent country extremely fertile. About a quarter of a mile south of the church, adjoining to a spacious gravel walk adorned with beautiful elms, rises the CHELTENHAM SPA.

The spring issues very slowly from a sandy soil intermixed with loam and a bed of blue clay; and though it has been calculated to yield only about 35 pints in an hour, yet, under the present frugal management, it is found adequate to every reasonable demand of those who drink it on the spot.

The well is sunk about six feet deep, and shut down with doors that exclude the free communication

cation with the external air, and the water is raised by a common pump. The sides of the well are tinged with a yellow ochre, where a saline efflorescence has also sometimes been observed to germinate.

It is recorded, that the medicinal virtues of this spring first began to be noticed about the year 1715; since which it has been more and more frequented during the summer months, and is now become, next to BATH, perhaps one of the most genteel and fashionable places of resort in the kingdom. Already Cheltenham exhibits a handsome Pump-room, two elegant Ball-rooms, and a Theatre. For which the company are principally indebted to the zeal of the public-spirited proprietor of the Spa, WILLIAM MILLER, esq; who has spared neither pains, nor expence, in his laudable exertions for the accommodation of a numerous and polite company.

Since the former impression of this essay, I am glad to find that many causes of complaint have been removed; that the town has been paved and lighted; the public roads repaired; the inns and lodging-houses rendered more commodious; and that other important improvements, are now under contemplation.

In

In the year 1780, SIMEON MOREAU, esq; was elected Master of the Ceremonies, who continues to preside over the public amusements; which are, we are informed, conducted with the utmost propriety, and that during his administration the company have increased from 374 to 1320!

But to *crown* the whole, this favoured spot has lately, in consequence of the King's indisposition, (and the advice of his Physician Sir GEORGE BAKER) been honoured by their MAJESTIES ROYAL PRESENCE. By this welcome, though very unexpected visit, the spring has acquired additional *eclat*, being now distinguished by the appellation of the ROYAL SPA of CHELTENHAM; but still MORE by its SALUTARY EFFECTS on his MAJESTY'S HEALTH, and by RESTORING the BEST and MOST AMIABLE of KINGS to a loyal and grateful people.

Sensible Qualities of the Water—Specific Gravity—Temperature.

The water, on being poured into a glass, appears tolerably clear, though not of a crystal transparency. After standing a few minutes, air-bubbles are seen to collect on the sides of the glass, and at length the water becomes less pellucid. When drank fresh at the pump, it first imparts a certain smoothness

to

to the palate, followed by a brackish bitter taste, and emits a slightly fetid, or sulphureous odour. This last becomes more perceptible on certain changes of the atmosphere, and particularly against rain. When shook briskly in a close phial, if the cork be suddenly drawn, it discharges more air-bubbles than common water treated in the same way.

Its specific gravity, when fresh drawn, has been computed at 50 grains in a pint greater than that of distilled water; and by exposure to the open air, has sometimes increased to near 70. I have lately found on examining it accurately, after it had stood several months in bottles tight corked and sealed down, that its increased gravity then only amounted to 66 grains.

The temperature of the water, on sundry trials, and at different times of the day, I perceived to vary between 53 and 55° of Farenheit's thermometer, being a few degrees warmer than some of the neighbouring pumps and springs, with which it was compared.*

* The temperature of a well in the adjacent grounds of Lord FALCONBERG, which seems to partake of a similar saline impregnation, but devoid of the Chalybeate principle, was only 51°, though shut up in like manner from the outward air; whereas a new Chalybeate spring at the opposite extremity of Cheltenham, near the mill, which was opened for my inspection, proved

*Experiments, exhibiting its appearances with sundry
Precipitants.*

Exp. 1. *With tincture of galls*, it instantly strikes a vivid purple, which by standing grows darker, inclining to a dusky green, with a variegated pellicle on the surface. If a glass of the water be exposed to the open air, it entirely loses this tinging property in half an hour; and undergoes a manifest decomposition.

2. *Vitriolic Acid* produced a very slight ebullition, accompanied with a discharge of air-bubbles, and rendered the water more transparent. The same was afterwards observed with the nitrous acid, though in a slighter degree. Neither of these acids caused any precipitation.

3. *Lixivium Tartari* occasioned a milkiness, followed by a copious precipitation of a white sediment.

4. *Solution of Silver in Nitrous Acid* instantly produced white clouds, followed by a dark pearl-coloured precipitation of a mucilaginous appearance nearly of the same temperature as that of the Spa, though exposed to the air.

ance, which afterwards proved to be a true *Luna Cornea*.

5. *Solution of Mercury in Nitrous Acid*, prepared with heat, produced thick clouds, and a brown rusty precipitation inclining to yellow, after standing some time.

6. *Solution of Sugar of Lead* occasioned white clouds, followed by a precipitation of a whitish sediment, which after standing became brown, inclining to black.

7. *Solution of Corrosive Sublimate* produced a whitish cloud, and, after standing some time, a slight precipitation ensued of a darkish colour.

8. *New Milk* mixed uniformly with the water without affording any mark of coagulation, nor did it visibly coagulate, as some have asserted, even when boiled with an equal quantity of the water.

9. *Lime Water* rendered it turbid, and a precipitation of the lime ensued.

10. *Soap* dissolved in the water was immediately decomposed, and the solution put on a curdly appearance.

11. *Syrup*

11. *Syrup of Violets* produced a bright green colour, which, after standing, inclined to a yellowish hue.

12. *Common Water distilled*, being used as a standard, underwent no visible change on the addition of the foregoing precipitants, except the solution of silver, which produced slight streaks, but without destroying the transparency of the water, or causing any precipitation.

Volatile Contents—how obtained.

13. A pint of the Cheltenham water, fresh drawn into a Florence flask, yielded spontaneously about two ounce measures of air into a limber bladder previously cleared of its air, and firmly tied to the mouth of the flask. And after being placed some time in a vessel of boiling water, it gave out a further quantity, so that the whole appeared to amount to three ounce measures. The air thus collected was conveyed into a large bottle of lime-water, the mouth of which was inverted in quicksilver, and the whole agitated gently from time to time. Upon which the lime-water became turbid, and a precipitation of the lime ensued. About two-thirds of the air being imbibed by the water, and having precipitated the lime, was evidently fixed air. The residue, which appeared to be common air, was

doubtless in a *phlogisticated* state, for reasons that will be hereafter assigned. The water in the flask had now totally lost its tinging property with galls, and was become vapid to the taste, on being thus deprived of its aërial principles.

Solid Contents collected by Evaporation.

14. A gallon of the water, being gently evaporated to dryness, during the process, threw up to the surface a whitish pellicle, which afterwards subsided, and when the water was consumed, there was left a brown mass tinged with ochre. The salts obtained from it by repeated elutriation with distilled water, and subsequent evaporation, weighed - - - 485 grs.

Residuum left in the filter, when dried	70
<hr/>	
Total	555

The salts shot into irregular hexagonal and tetragonal prisms, the two opposite sides broader, truncated at one end, and at the other terminated by quadrangular pyramids; cold, and bitter to the palate, and in appearance extremely similar to the vitriolated mineral alkali, called Glauber's salt. Besides which, were found a few cubic crystals amounting to five grains, which proved to be sea-salt, together with a portion of saline matter, which towards

towards the close of the evaporation assumed a soft powdery form, not admitting of crystallization, which appeared to consist of a mixture of magnesia with the marine acid. The whole process was now repeated a second time, with the same quantity of the water, and nearly with the same result. The crystallized salts were preserved, and afterwards subjected to the following experiments.

Properties of the Cheltenham Salts.

15. On dissolving some of the larger crystals in distilled water, and adding a few drops of a solution of vegetable fixed alkali, a white cloud appeared, and remained suspended about the middle of the glass.

16. On lime water being dropt into a solution of this salt in another glass, it produced small streaks of a light pearl colour, but no precipitation ensued, whereas a solution of common Glauber's salt underwent no change from either fixed alkali, or lime water, but remained transparent as before.

These two last experiments have several times since been repeated with different parcels of the Cheltenham salts. While with some of the crystals, the alkali and lime water produced a miliness,

ness, and even precipitation; with others not the least change ensued, and the solution retained its transparency after standing, similar to a solution of Glauber's salt, with which it was compared.

Here the experiments appear to clash considerably, and the difference in the result seems to render it very equivocal, whether the Cheltenham salts are to be considered of the *Glauber* or *Epsom* kind. But this difficulty is readily explained:—The experiments prove both these salts to be present, and that those crystals which undergo *no* decomposition with an alkali are real *Glauber* salts, while those that *do*, are as clearly *Epsom*.

Nor is this combination incompatible, since both are often found in the same water; they crystallize together, assume the same appearance, nor can they be accurately separated without a tedious process by double elective attraction, which is by no means necessary, as they are known to agree so nearly in their medicinal properties. When combined, however, they mutually promote each other's solubility, and general operation.—A circumstance hitherto little known, though worthy to be observed in the administration of other saline medicines, as well as those of the purgative kind.

17. On adding a few drops of tincture of litmus,* or syrup of violets, to a solution of Cheltenham salt in distilled water, no sensible change inclining either to red or green ensued; nor was the blue tinge of the litmus rendered more intense, neither did any effervescence arise with acids or alkalis.

18. Paper dipt in a saturated solution of this salt, and then dried, did not deflagrate when applied to the flame of a candle, as it is known to do when dipt in a solution of nitre, nor did it burn with a *green* flame, as it is wont to do from a solution of calcarious nitre.

19. The Cheltenham salt was found to be perfectly soluble in nearly its own weight of distilled water at the temperature of 60° , and in less than two-thirds of its weight of boiling water; whereas the common Glauber salt required nearly twice its weight to dissolve it at the temperature of 60° , and

* Litmus is a blue pigment formed from Archal, a species of moss brought from the Canary and Cape de Verd Islands. The tincture is obtained by steeping this pigment inclosed in clean linen cloth in distilled water. A single drop of concentrated vitriolic acid has been found to communicate a visible red tinge to 300 grains or 408 cubic inches of this blue tincture. Hence its utility as an exquisite test for discovering the minutest portion of acidity in waters, insomuch that fixed air itself, one of the weakest acids hitherto discovered, is incapable of escaping it without being immediately discovered.

5-6ths at the boiling point. Although this salt contains near half its weight of water in its crystalline state, it did not prove *deliquescent* like *calcarious nitre*; but remained permanent in a moist air, and, in a dry air, calcined spontaneously. Thrown on ignited iron, it liquefied, rising into blisters, but without affording any detonation like nitre, as some have pretended,* neither did it coagulate milk when boiled with it, as others have alledged.†

Of the Residuum.

20. The earthy residuum, as already mentioned in Exp. 14, which remained insoluble in water, weighed 70 grains. It effervesced with acids, and turned syrup of violets green. The vitriolic acid converted part of it into a selenitic substance, or gypsum, similar to that which forms an incrustation on the inner surface of the kettle, in which the water is occasionally heated at the Spa.

21. The residue, when dried, did not discover any magnetic property, till it had undergone a slight calcination with charcoal, when some minute particles were attracted by the magnet.

* See Dr. SHORT on Mineral Waters.

† Editor of the 4th Edition of RUSSEL on Sea-Water, 1760.
Also RUTTY on Mineral Waters;—p. 133.

The volatile Parts once lost, whether recoverable.

22. A gentleman who frequents the Spa, having preserved two bottles of the water 22 years, as a matter of curiosity requested me to examine it. The water on being poured into a glass was clear, and perfectly free from any bad odour. It turned syrup of violets green, but tasted flat; and had entirely lost its tinging property with litmus, and also with galls, agreeably to what I expected.

23. Having ordered two bottles of the water fresh drawn to be well corked and sealed down at the pump before my departure, I examined it by sundry experiments six weeks after my return to Bath, and found it still retained some slight degree of smartness on the palate, and changed tincture of litmus to a faint red, but had quite lost the tinging property with galls.

24. Leaving the bottle uncorked till the water became quite *vapid*, it was then poured into the glass apparatus invented by Dr. Nooth for impregnating water with fixed air, and exposed to the effluvia of an effervescent mixture of chalk and vitriolic acid, till it was fully saturated. It now tinged the litmus of a vivid red; sparkled on being poured into the glass, and tasted brisker than water
fresh

fresh drawn at the fountain head. On immersing a small piece of iron in the water, and leaving it in the vessel all night, the water next morning had completely recovered the chalybeate quality, struck a deep purple with galls, and finally, on exposure to the air, threw up a variegated film to the surface, which reflected the prismatic colours.

General Inferences from the preceding Experiments.

I shall now proceed to illustrate the foregoing experiments, and to deduce from them a few inferences by way of induction.

EXP. I. The sundry *precipitants* employed in analyzing waters, it must be observed, can only serve to point out the *quality*, not the *quantity*, of their respective mineral ingredients. From this experiment with tincture of galls, it appears, that the water contains iron, which is farther confirmed by the ochrey sediment which it deposits on the sides of the well. A single drop of the tincture is sufficient to give a distinct purple tinge to 100 cubic inches of distilled water, containing only three grains of martial vitriol, yet three grains of the vitriol contain no more than $\frac{1}{24}$ th of a grain of iron. Where the quantity of iron is considerable, instead of a purple, it gives a black tinge. When it exists in

in the form of martial vitriol, the colour is more permanent; but when it is suspended by fixed air, it is extremely evanescent, as in the present instance. The reason why this water so soon loses its tinging quality, will be afterwards more fully considered.

2. From this experiment with *vitriolic acid*, we learn that the water contains an *earthy* substance suspended by means of fixed air: The vitriolic acid, by superior attraction, seizes the earth, and forces the air to quit its hold; hence the copious discharge of air-bubbles, and increased transparency. It further appears, that the earth is not of the siliceous kind which is insoluble in water, nor the *terra ponderosa* (sometimes suspended in water by fixed air) which would have been precipitated by the vitriolic acid in form of ponderous spar. It must therefore be referred either to the calcarious, or absorbent class.

3. Here the fixed alkali, by the same law of attraction, shews the presence of earth, or a neutral salt with an earthy or metallic basis.

4. *The Solution of Silver*, in this experiment, points out the presence of *marine acid*, which it enables us to detect in a very large quantity of water,

water, especially when the precipitate, as in the present instance, forms a *luna cornea* reducible by calcination to its pristine state of pure silver.

5. *The Solution of Mercury* discovers a neutral salt, of which the vitriolic acid forms one of the ingredients, but is not sufficient to determine the nature of its basis, or whether it be Glauber's Salt, or Epsom; both of which appear to be present. The brown rusty precipitate denotes an impregnation of iron.

6, and 7. *Here the Solution of Lead, and of Corrosive Sublimate, betray signs of hepatic air, or a very slight sulphureous impregnation, and at the same time confirm the presence of calcarious earth, or magnesia, held in solution by means of fixed air.*

8. In this experiment, the *ready union of the water with milk*, without producing any decomposition, shews the error of those practitioners who prohibit a milk diet during a course of this water, from its supposed coagulating quality. And the result of exp. 19, may be sufficient to correct the same popular prejudice, which also attributes a coagulating property to the Cheltenham salts.

9. *The Precipitation of the Lime*, in this experiment, affords a satisfactory test of the presence of
fixed

fixed air. The air, having a more powerful attraction for the quick lime than for the water, quits the latter to unite with the former; and thereby renders the lime insoluble in a watery menstruum. Hence the turbid appearance, and subsequent precipitation of the lime.*

10. *The decomposition of Soap* argues the presence of *calcarious earth*, or *magnesia* combined with an acid, which acid detaches the oil of the soap from the alkali with which it was combined, and occupies its place. Fixed air, being an acid, is capable indeed of producing a similar effect, though in a far less sensible degree.

11. *The bright green colour imparted to Syrup of Violets*, inclining to yellow, tends to confirm the conclusions drawn from some of the preceding experiments, concerning the presence of *earth*, and particularly of *magnesia*.

Professor BERGMAN has perhaps too hastily rejected syrup of violets from the class of chemical

* Here it is not a little curious to observe, that if a certain portion of fixed air be added, the lime is presently re-dissolved, and the water immediately recovers its former transparency. If an additional quantity of lime-water now be added more than sufficient to saturate the fixed air, the turbid appearance instantly returns, and these changes may be alternately renewed at pleasure.

tests, because he thinks it can seldom be had genuine; that it spontaneously acquires a red colour by fermentation; and finally, that it is rendered green, not only by *earths* and *alkalies*, but also by *iron*. These inconveniences, it is true, occasion some ambiguity, but may be easily obviated. For,

1st. The *genuine* syrup is readily distinguished by changing a solution of corrosive sublimate *green*, while that which is *spurious* turns it *red*.

2dly. The alteration produced by spontaneous fermentation is too palpably perceived before hand, to deceive even a common observer.

3dly. Whoever has compared the green produced by *iron* with that produced by *alkalies* or *earths*, will easily be enabled to distinguish them on every future occasion.

To a solution of a single grain of martial vitriol, and of each of the other substances, in a wine-glass of rain or distilled water, add half a tea spoonful of *genuine* syrup of violets. After standing, it will be found, that the vitriol yields a *dull* green inclining to *black*; the alkali, a *bright* green; chalk, a *light* green inclining to *blue*; magnesia, a lively bright green with a *yellowish* cast, as in the above experiment.

The

The blue juices of other vegetables, though much esteemed, are unequally affected by acids, and alkalies.—Litmus, instead of *green*, is rendered more intensely *blue* by *alkalies*. Indigo, instead of growing *red* with *vitriolic acid*, undergoes no change of colour. Turnsole, and Litmus, are turned *red* by fixed air, while the *other* vegetable blues remain *unchanged* by this weak acid. Where certainty can only be attained by the coincidence of many results, syrup of violets, with the above cautions, may reflect no small light, and therefore ought in no wise to be discarded from the place which it has long deservedly held in the class of re-agents.

12. This experiment with distilled water affords a striking contrast between the effects of precipitants on the Cheltenham water, and simple water free from any mineral impregnation. For the appearance observed with Solution of Silver, can only be attributed to some slight *accidental* impurity. Nor can this be entirely avoided, even when the water is repeatedly distilled from the purest snow.

13. This experiment presents us with an *aërial fluid*, a considerable portion of which being loosely attached to the water, exhaled spontaneously into the bladder placed to receive it, while the residue being more closely united to the terrene parts, required

quired a boiling heat to detach it. The quantity obtained by this, and the former process, amounted to about four ounce measures, three-fourths of which were *readily* imbibed by water; and, as this portion decomposed lime-water and reddened litmus, was undoubtedly fixed air, and the residue may be safely considered as *phlogisticated*, because *pure* atmospheric air is *incompatible* with the presence of *iron* and *hepatic gas*; since by seizing the phlogiston, it decomposes the metal, and becomes *phlogisticated*.

To ascertain the quantity of aërial fluids in a given quantity of water with exactness, is by no means easy. The method proposed by Sir T. BERGMAN, at first view, appears preferable to that which, through necessity, I here had recourse to. His apparatus indeed is esteemed the least exceptionable of any that has been invented. I have since found, however, that it is liable to much greater fallacy, from the rarefaction of the air in the tube of the retort, than the learned Professor seems to have been aware of. Nor is the method proposed by M. GIOANNETTI, and other foreign chemists, more to be depended on. They endeavour to determine the quantity of fixed air by *weight*, rather than by *bulk*, estimating this by the weight of the calcarious earth precipitated by it from lime water. But the difference

difference in the result of their calculations evidently proves that it is not less difficult to determine with *precision* the quantity of fixed air contained in calcareous earth, than the proportion which the bulk of this fluid bears to its weight.

The spontaneous evaporation of the aërial volatile parts (when no artificial heat is applied) may assist us in explaining the increased specific gravity of the water, after standing some time in an open vessel.

14. From the experiment by evaporation, we ascertain with more certainty the quantity of neutral salts, and other ingredients of a fixed nature, contained in a gallon of the water, each of which shall be now considered.

*Its Purging Salts—whether Vitriolic—or Nitrous
—how distinguished.*

15, 16. From these experiments it appears, that the purging salts of this water consist of vitriolated mineral alkali, and vitriolated magnesia; or, in more familiar terms, of an assemblage of Glauber and Epsom Salts. Some have supposed these two salts to be perfectly similar. They, agree, it is true, in their sensible qualities, and frequently correspond in the form of their crystals. The acid is the same in

both; they differ however in their basis. The Glauber salt having the *mineral alkali* for its basis; the Epsom salt, *magnesia*. Hence a solution of the former remains undisturbed by the addition of a fixed alkali, or lime water, while the latter grows cloudy, and undergoes a decomposition. These salts therefore are essentially different, though apparently combined in the water, which is no uncommon circumstance among saline waters of this class. The crystals of the Epsom salt are sometimes so large, that they are sold in England for Glauber's salt; and on the other hand, in France, Glauber's salt, being reduced to small *spiculæ* by agitation during the crystallization, is vended for Epsom. But these petty frauds may be easily detected by the addition of lime water, or a fixed alkali, either of which afford an infallible test, agreeably to what has been already hinted.

17. This experiment shews, that the Cheltenham salts are neither acid nor alkaline, but as perfectly neutral as the purest Glauber or, Epsom salts of the shops, when duly prepared. Nor can there be any material difference between the natural, and artificial, either in their chemical or medicinal qualities, when reduced to the same degree of purity.

18, 19. Afford

18, 19. Afford incontrovertible evidence that the salt of this water, which has been pronounced to be *nitrous* by Dr. SHORT; and repeatedly echoed as such by succeeding writers, does not, in truth, bear the remotest analogy to nitre, nor yet to the *valgoe* of the ancients, (termed *fossil alkali* by the moderns) neither of which are of a purgative nature. Neither does it bear any resemblance to *calcarious* nitre, as others have asserted; for the Cheltenham salt yields permanent crystals; the calcarious nitre, a *deliquescent* mass, incapable of a perfect crystallization. The Cheltenham salt is an *active purgative*; the nitrous salts possess *no purgative quality whatsoever.*

The reason why the Cheltenham salt (in experiment 19) proved soluble in so small a proportion of water, may perhaps be thus accounted for: 100 grains of this salt contain of vitriolic acid about 19 parts; of pure magnesia, 33; of water, 50. The water essential to the crystals of this salt, being so very considerable, must proportionably increase the menstruum, and consequently promote the solution.

Thus water, after being fully saturated with sal ammoniac, becomes capable of dissolving a much larger quantity of corrosive sublimate than the same quantity of plain water can hold in solution, because the water essential to the ammoniacal salt, is

now superadded to the menstruum; of which many similar instances have been already mentioned in the preceding Essay on Water.

20. This experiment shews, that the earthy residuum contains a selenitic matter as well as magnesia, and that the latter is combined with fixed air; which, being dislodged by the more powerful acids in this experiment, produces a conflict, and flies off during the effervescence.

21. This confirms the result of the experiment with galls, concerning the presence of iron, and shews it to be in a calciform state. By calcination with an inflammable substance, it acquires the necessary portion of phlogiston to render it sensible to the loadstone, though not so much as is required to reduce the calx into its metallic state.* With respect to the quantity of iron contained in the water, it is undoubtedly small. Dr. LUCAS estimates it at four grains in a gallon: but it is by no means easy to ascertain this with accuracy, or to

* Iron, though hitherto considered as a *simple* metal, has lately been discovered to contain a portion of *Plumbago* and *Manganese*. How far the union of these substances may influence its composition, or vary its effects in medicine or the arts, may prove an object worthy inquiry, particularly in England, where this metal undergoes so many different processes, and exercises the ingenuity of so many expert chemists, and artizans.

collect the calx in a separate state by the usual method of filtration, without waste, and therefore it was not here depended on. If we may be allowed to judge from the purple tinge communicated to distilled water by an adequate proportion of martial vitriol, the iron contained in a gallon of Cheltenham water, may be presumed to amount to four grains and a half, if not five grains.

22, 23. We have already shewn, by *Exp. 1*, that the water when exposed to the air in an open vessel, in the ordinary temperature of the atmosphere, was deprived of its purple tinging quality, in half an hour. This decomposition of the chalybeate principle first takes place at the surface, which is most exposed; the phlogiston of the metal being attracted by the dephlogisticated air of the atmosphere, the iron is decomposed. Hence the variegated film. The water, when tight corked, and sealed down, was found at the end of six weeks to communicate a very faint red to the tincture of litmus, and therefore to have retained part of its fixed air, though not sufficient to suspend the chalybeate principle; for it no longer gave a purple tinge with galls. It is no wonder then that the bottle which had been kept the space of twenty-two years, was found to have totally lost both these properties.

How to preserve the Mineral Spirit—or to recover it when lost.

24. It has long been a received maxim, that mineral waters, especially those of the chalybeate kind, can only be drank in perfection at the fountain head, and that when their mineral spirit (as it is termed) is once lost, the chalybeate principle vanishes; and that both are totally irrecoverable. The experiment, however, (page 58) affords a remarkable example of the contrary, and also points out an easy and simple method, by which both these fugitive principles may again be completely restored:—A pleasing circumstance to those persons who cannot attend the spring, but are obliged to send for the waters at a great distance. It also supplies a convincing proof of the *real* nature of the mineral spirit, and its *perfect identity* with fixed air: that by the intervention of this subtile medium, the iron is converted into a saline substance, and in that state is naturally dissolved in the water. That when this flies off, the iron does not accompany it, as is vulgarly supposed, but only subsides, and is deposited at the bottom of the bottle, in form of ochre.

It is observable that iron cannot be duly suspended in water by fixed air, either naturally, or artificially,

artificially, without a superabundant quantity of air, beyond what is merely necessary to the solution of the iron. In order, therefore, to preserve a chalybeate water in its full efficacy, it is necessary to re-impregnate it occasionally with iron, and also with an additional quantity of fixed air, till it is super-saturated with the latter.

Some attempt to preserve the mineral spirit of these waters, when intended for transportation, by pouring a little olive oil into the neck of the bottle before it is corked; but this method is very exceptionable, and inadequate to the intention.

The mineral spirit is too subtle to be wholly confined by a thin stratum of oil. The oil is moreover apt to contract a rancid quality, which it soon imparts to the water, and renders it offensive.

Others, still more improperly, direct the water to be kept in a warm room. This produces an intestine motion in the mineral contents, which detaches the aërial principles, and soon renders the water vapid.

Here, I shall attempt to explain a chemical problem, which has long perplexed Philosophers, namely, the decomposition which certain chalybeate waters undergo, even in bottles *hermetically sealed*,

sealed, and when every other precaution has been used to prevent it. The cause appears to be this: Though glass be impermeable to aërial fluids, yet the principle of *heat* (which in *certain quantity* is essential to their composition) easily pervades the pores of glass, and even penetrates the densest metals. The escape also of this subtle medium instantly renders the menstruum incapable of suspending the mineral contents, with which it was connected, and hence a decomposition, and precipitation must inevitably ensue.

Water, I find, imbibes fixed air more powerfully in a cold, than in a warm season, and retains it more tenaciously in proportion as its temperature approaches the freezing point: and yet, what is remarkable, the moment it undergoes congelation, it loses it entirely, for ice-water is destitute of fixed air. Hence the presence of fixed air appears to be incompatible with water, as soon as the latter approaches to a solid form: consequently, to preserve a permanent union between them, the extremes both of heat and cold must be carefully avoided. The brisker kind of mineral waters, therefore, whose chalybeate principle is suspended by fixed air, ought to be kept in a cool cellar of equal temperature, the bottles being well secured, and placed with the corks downwards.

By

By these means the foreign mineral waters, imported at a great expence, might be preserved in a much higher degree of perfection than we commonly find them. Even in their present state, they might be considerably improved by re-impregnating them with fixed air; though this, I find, is by no means sufficient to enable them again to take up the ochrey sediment, after being once deposited.—Why?

Principles contained in a Gallon of the Cheltenham Water.

From the preceding experiments, a gallon of the Cheltenham water (wine measure) appears to contain the subsequent principles, and nearly in the following proportions, viz.

Of Solid Contents.

	<i>Grains</i>
Purging salt, partly Glauber, partly Epsom,	480
Marine salt	5
Iron, combined with fixed air, nearly	5
Magnesia, combined partly with marine acid, partly with fixed air	25
Calcarious earth, combined with vitri- olic acid in form of selinite	40
	<hr/>
Total	555

Of

Of Aërial Fluids.

	Ounce Measures
Fixed air, combined with the water,	24
Phlogisticated air, with a portion of hepatic air also loosely combined with the water	8
	Total 32

Exclusive of a small portion of fixed air, retainable by the earthy substances, even in the heat of boiling water, or liable to be re-absorbed during the process. Nor ought a slight difference in the result of experiments to be wondered at, since not only the aërial fluids, but also the more solid contents of mineral waters, are found to vary at certain seasons, and according to subterranean changes, which are continually going on in the bowels of the earth.

By the term *Hepatic Air*, is meant sulphur converted into a volatile state, by union with the principle of heat. In consequence of this combination, it assumes the form of a permanently elastic gas or vapour, and becomes miscible with water. Though extremely fugitive in its nature, yet it is sufficiently distinguishable by the peculiar fetid odour with which it not only impregnates the water, but also the alvine discharges of those who drink it. Dr. LUCAS ascribes this odour to a putrid taint, in consequence

sequence of the water being shut up from the common air. But then why is there not a similar odour perceptible in the water of other wells, and pumps shut up equally close? besides, does not the constant influx and reflux of the spring, not to mention the antiseptic quality of the fixed air, and neutral salts with which the water is impregnated, strongly militate against this *supposed* putrid quality? Others, with much greater probability, have attributed it to sulphur in its own proper form; but since the water neither undergoes any precipitation of sulphur by concentrated nitrous acid, nor discolours polished silver when immersed in it, we must not expect to obtain *real* sulphur from the water, though its constituent principles are evidently present in a volatile evanescent state.

Here, the present weak impregnation of the hepatic gas the more easily eludes the common tests, than where the water is more fully saturated with it. May not this subtle vapour derive its origin from a decomposition of the sulphur contained in the pyrites or iron ore, which supplies the Chalybeate principle? and may not the action of *pure* air on its phlogiston, extricate the principle of heat essential to the volatilization of the sulphur? and finally, may not this also explain why the water is rather

rather warmer than the neighbouring springs, and its air in a plogisticated state?

Now whether these constitute the whole contents of the water, or whether there may not be some other *unknown* principle, some link of the chain yet wanting, I shall not venture to decide. For the recombination (as has been already observed) ought exactly to correspond with the decomposition, and a reunion of the different principles ought to be capable of reproducing the natural water, before the analysis can be pronounced absolutely complete.

But this doubtless is a most arduous task, and it must be confessed, that the researches of our best writers on Mineral Waters have rarely, if ever, attained so high a pitch of satisfactory evidence; nor was there opportunity of putting the matter to the test in the present instance, because the entire contents were previously subjected to other necessary experiments. The rapid progress of philosophical chemistry, however, encourages us to hope, that it may still be accomplished at no very distant period. And that in the interim, a more accurate investigation of the mineral substances with which nature impregnates waters, may enable us, in time, more fully to comprehend her hidden processes, and finally

finally to produce *artificial* impregnations that may emulate, or perhaps even surpass, the *natural* ones. For, admitting the quality and quantity of the several ingredients to be once thoroughly understood, it is humbly conceived that no very essential difference can arise from the hand that combines them.

Their Medicinal Properties separately considered.

Here the reader will naturally expect some account of the medicinal virtues of the several component parts of this water in a separate state; but such an account, though ever so circumstantial, it is feared, would fail of conveying the desired information concerning the genuine effects of the water when drank fresh at the spring. Many of its principles are of an active nature, some apparently inert; but the medical effects of the compound are often very different from what might be expected from the known qualities of the ingredients; therefore we must look for its medicinal virtues in the aggregate, rather than in the *constituent* parts, though both ought to be carefully explored.

It may be proper to observe in general, that the neutral purging salts, which abound in this water, are the chief ingredients wherein its purgative qualities evidently reside. Their virtues agree with those

those of the artificial Glauber and Epsom salts; but the superior solubility of the Cheltenham salt, containing an union of the two, becomes a more active purgative than either of them taken separately; and this quality is greatly heightened by very copious dilution. Hence a quarter of an ounce of the salt contained in a quart of the water, operates more briskly than a whole ounce of common Glauber salt when dissolved only in two ounces of water.

Hence the impropriety of administering purging salts in such a trifling quantity of the menstruum; and yet this is the fashionable method generally adopted by modern practitioners, who, in compliance with custom, limit every draught to a small two-ounce phial, which in fact contains little more than an ounce and half. In this quantity of water is an ounce of the salt directed to be dissolved; and to complete the absurdity, it is generally interlarded with manna, senna, or tamarinds, when, for want of proper dilution, when cold, the mixture presently congeals into an unsightly coagulum, with the salt firmly crystallized.

The Cheltenham salt being prepared in considerable quantity from the water at the Spa, in a portable form, its crystals may be preserved in bottles unimpaired by time, and may be usefully employed

at

at a distance from the spring, as a safe and gentle purgative. It may also afford an useful substitute for the water itself in inflammatory, or hectic disorders, where the chalybeate principle might be deemed improper. By adjusting the dose, it may be determined to operate as a brisk purgative, or mild laxative and diuretic, and may therefore be added occasionally to quicken the operation of the water, when it passes off too slowly; or may be dissolved in a moderate quantity, where large draughts of cold water are deemed improper, as in hydroptic and leucophlegmatic habits.

APPENDIX APPERTAINING TO THE USES OF THE WATER.

The *Sea-Salt*, though very minute in quantity, may, when largely diluted, contribute its share to the purgative and diuretic effects of the other saline ingredients. And as this salt has the singular property of passing, unaltered in its nature, through the several stages of circulation; and after all, of being recoverable from the blood and urine of animal bodies, its deobstruent effects in the remote parts of the frame may be more considerable, than has been generally imagined. Does not the known efficacy of sea-water in this respect, even when drank in small quantities, as an alterative, tend to corroborate this opinion?

The IRON combined with the AERIAL ACID constitutes an active saline chalybeate, which contributes to warm and invigorate the system, to promote appetite and digestion, and to prevent languor during the evacuation.

The MARINE MAGNESIA, as a laxative and absorbent, tends to correct acidities, and vitiated bile in the first passages, and to promote their expulsion. It may also increase the purgative and diuretic power of the other neutral salts.

Whether the CALCARIOUS or SELENITIC MATTER can really impart any useful medicinal quality to this, or any other water, seems very problematical. It requires at least 500 times its weight of boiling water to dissolve it, and may therefore be considered as almost insoluble by the animal fluids. Waters which abound with it are extremely hard, and generally unfit for culinary purposes ; and the inhabitants who are obliged to drink them, are often infested with the Bronchocele,* and other glandular tumors. The Caroline water, indeed, as well as some other hard waters, have been ex-

* A large tumour of the neck, to which females are peculiarly liable where hard waters abound. At the foot of the Alps it is said to be endemic, also in the Peak of Derbyshire; hence the disease has been termed the DERBY NECK.

tolled in cases of stone and gravel; but their virtues, which have been erroneously ascribed to the earthy matter, may, I think, be more rationally explained from the fixed air and mineral alkali which they contain.

However improbable the theories may be which have been advanced concerning the nature and operation of such springs, I shall at present pass them over in silence. It is sufficient to observe that the Cheltenham water, by its purgative and diuretic qualities, expedites the passage of these terrene matters through the system, sufficiently, at least, to obviate their bad effects.

FIXED AIR, though an important principle in this water, seems to have been unknown to the more early writers; and the moderns, among whom Dr. LUCAS, seem to have strangely confounded it with the volatile vitriolic acid, from which, however, it is very essentially different. The volatile vitriolic acid is easily distinguishable by its irritating corrosive quality, which destroys the colours of organized bodies; also by its stronger attractive power to other substances, and by being condensible into drops of genuine vitriolic acid. Fixed air, on the contrary, is a milder acid, is void of acrimony, and even destroys the causticity of other substances.

In its separate state, it is not condensible into drops, but remains a permanently elastic fluid.

The properties of fixed air, indeed, have not been minutely examined till of late, notwithstanding it is almost every where present; insomuch, that few waters are wholly divested of it, except those of ice and snow; which perhaps may be one reason why these waters prove so unwholsome when used internally, unless, by previous exposure in open vessels, they are suffered to re-imbibe a proper quantity of this enlivening fluid from the atmosphere.

Though it appears to be much less predominant in the Cheltenham Spa, than in some of the more brisk acidulous waters, yet we find (from experiment 13) that the quantity even here is by no means inconsiderable. It is that portion alone which is loosely attached to the water, so as to be separated by the heat of boiling water, which can impart any active medicinal power to the water. The residue, which adheres closely to the earthy basis, so as to resist this degree of heat, cannot perhaps be dislodged by any other process, except congelation or calcination: and therefore is probably too inert to exert any medicinal virtues, or to merit any further consideration at present.

It appears from observation, that fixed air communicates to simple water, an antiseptic, diuretic, exhilarating, and even inebriating quality. It is evidently this aërial principle which gives the agreeable smartness and poignancy to mineral waters, and which imparts life and energy to the other ingredients, by which they are enabled to pervade the remotest recesses of the human frame, and subdue some of the most obstinate diseases. To what other principle in their composition can we rationally attribute these surprising effects? Not surely to the water alone, which is totally incapable of producing them; nay even injurious, when divested of this necessary ingredient in its composition; much less to the mere solid contents, which, either jointly or separately considered, are too inactive to exert such extraordinary powers.

The PHLOGISTICATED and HEPATIC AIR, which also appear to enter the composition of this water, may produce powerful effects proportionate to the peculiar nature of such subtile fluids. The medicinal powers of the *former* are as yet wholly unknown: the *latter* may be expected to impart to the water virtues similar to those of Harrowgate, and other sulphureous springs, in proportion to the degree of impregnation. Hence, perhaps,

may be explained why this water is more efficacious in certain cutaneous diseases, than some other saline waters, which are destitute of the sulphureous gas.

The medicinal properties of both these elastic fluids are still too little understood to warrant us in drawing *a priori* any certain conclusions concerning them. It may however be observed in general, that from experiments it appears that fixed air, phlogisticated air, and hepatic air, agree in their known properties of extinguishing flame, and in suffocating breathing animals; and yet what is singular, when combined with water, they not only are innocent, but even medicinal.

As Cheltenham Water seems to derive its exhilarating quality from its aerial impregnation, curiosity prompted me to make the following trial of its effects on vegetation.

Exp. 25. Two plants of spear-mint were placed with their roots and stems in two separate bottles; one of the bottles containing Cheltenham water fresh drawn; the other, common pump water. The plant in the Cheltenham water, within two days drooped and withered, while the other, in pump water, remained in a healthy flourishing state.

Hence,

Hence, though this impregnation be *salutary* to the *human* constitution, it appears to be very *unfriendly* to the principle of *vegetation*.

Exp. 26. Having drank the Cheltenham water regularly, during the space of three weeks, (except a day or two that its use was purposely suspended) and having attentively observed its effects on myself, and others who drank it under my direction, it was generally found at the beginning to produce a slight giddiness, attended with drowsiness, sometimes head-ach, presently after it was taken; but these symptoms soon vanished, especially after walking a while in the open air.

As a cathartic, it operated in a very speedy, gentle, and certain manner, without occasioning gripes, faintness, or depression of spirits; so often complained of from the operation of common cathartics, particularly of the active or resinous kind.

It moreover promoted appetite and digestion, and manifestly increased the fluid secretions of urine and perspiration; the balance inclining sometimes to the former, at others to the latter, according to the state of the body, the degree of exercise, and other circumstances; when the weather was warm,

it passed off more freely by perspiration; when cool, by urine.

Diseases, wherein found beneficial—or apparently indicated by Analogy.

From the foregoing account it appears, that this saline chalybeate water is cathartic, diuretic, and sometimes diaphoretic, and that it operates by a very gentle stimulus, without evidently accelerating the circulation, or irritating the nervous system, like the rougher purgatives.

The operation of the water may be explained from considering the properties of the saline ingredients combined with a large portion of aqueous menstruum, actuated by aërial fluids, and constituting a medicated compound, mild, yet active; calculated at once, to clear the first passages, to purify the chyle and lymph, and finally to cleanse the whole glandular system.

Though rather unpleasant to the palate, yet it is friendly to the stomach, and congenial to the constitution. Uniting with the bile, and alimentary fluids, in its passage through the intestines, it powerfully excites the innumerable glands, dispersed over their whole internal surface, to a copious discharge of their contents. By which it not only
detoxifies

deterges the canals, through which it immediately passes, but also those of the liver, spleen, pancreas, and other neighbouring viscera, and thence is enabled to remove obstructions, and disburthen the glands in more remote parts. For whenever any particular gland is obstructed, or its functions impaired by a morbid determination of impure lymph, the only rational method of relieving such gland, is to produce an increased discharge, either from some other gland of the same class, or from those of the intestinal tube, the *grand emunctory* from which, as from a common shore, the recrementa of the food, and sundry other impurities are happily evacuated: by which means the obstructed gland is gradually cleared, and rendered permeable; and the morbid determination being altered, the weakened vessels gain time to recover their wonted tone, and elasticity.

Hence this water may be used as a powerful *evacuant*, or a gentle *alterative*, according to the state of the constitution, and the intention of the physician. If the intention be to produce a copious evacuation, it is to be administered in large quantities, and at short intervals. If the constitution will not admit of its use as a brisk evacuant, the intention is to be answered by a slower method, *viz.* that of an alterative; in order to determine it in small

small quantities, and at longer intervals, to pass into the blood, and to accompany all the fluid secretions, without sensibly increasing any of them. The *purgative* plan is best adapted to firm athletic constitutions; the *alterative*, to the delicate and relaxed. In both these ways, have waters of this class been found beneficial; and in the latter, not less perhaps than in the former, as appears from the observations of our best writers.

“ It is obvious (says the learned Dr. JOHNSTONE) .“ this water contains saline ingredients possessing “ different attractive powers, which though ba-“ lanced in the water, yet when mixed with animal “ fluids and salts, in the course of digestion, and “ circulation with the blood, must be so changed “ as to form new combinations, whence compounds “ possessing properties different from what existed “ before will be produced, and the system itself “ is changed.

“ By the solution of salts, *cold* is generated; by “ their uniting into new compounds, *heat* is pro-“ duced. Hence new stimuli, with other altera-“ tions, take place in the glands and remoter “ vessels of our system; and it is by these means, “ as well as *evacuation*, that these waters become “ beneficial,

"beneficial, and are really *valuable ALTERATIVE*
"medicines."*

* See Dr. JOHNSTONE's ingenious Tract on the Walton Water (near Tewkesbury) lately discovered—and which, by analysis, he finds *extremely* similar to Cheltenham water.

Certain writers severely reprobate the term *alterative* as vague and indeterminate, and therefore wish to banish it from medical language; to which I see no mighty objection, provided a more fit term can be found, and at the same time more expressive of the effects of that class of medicines, which are acknowledged to produce remarkable effects, without occasioning any sensible evacuation. Such are not only minute doses of mercurials, and antimonials, but of other saline substances, to which I have ventured to add saline mineral waters, all which evidently constitute *chemical stimuli*, whose *modus operandi* (whatever some may assert) remains altogether unknown.

Vain, therefore, has been found every attempt hitherto made, either to explain the action of chemical stimuli, on mechanical principles, or to deduce the specific effects of saline medicines from the figure or spiculated form of their crystals.

Of those salts which exhibit sharp-pointed *spiculæ*, how extremely different their operation, and effects! Compare but Epsom salt with corrosive sublimate; sal ammoniac, or nitre, with sugar of lead, or alum; all which present sharp points, or *spiculæ*, yet what similitude can be found in their operation?—what analogy in their effects?—Though convinced of the impossibility of explaining their action *mechanically*, I suspect this might nevertheless be accomplished on the known principles of *chemistry*. That this is not entirely impracticable, appears from the passage already cited from the ingenious Dr. JOHNSTONE.—Without however attempting any conjecture about the cause of their mysterious operation, I shall content myself with observing their effects. And till their *modus operandi* is better understood, shall still take the liberty to call them *alteratives*. For I cannot help retaining, with Dr. JOHNSTONE and other respectable writers, a secret partiality for that good old term.

The

The diseases in which this water has been found beneficial, or wherein it seems evidently indicated, are chiefly, if not entirely of the chronic kind, and may be considered under the three following heads: viz.

1. Those which principally affect the organs of digestion.
2. Those of the intestines, and other abdominal viscera.
3. Those of the lymphatic system, particularly the glands.

DISEASES.

I. Of the Stomach, whether arising from *indigestion*—*repletion*—or *spasm*, as — — — — — SICKNESS
VOMITING
ACIDITY
PAIN, &c.

II. Of the Bowels, and other abdominal viscera, whether from <i>redundancy</i> , <i>acrimony</i> of their contents, <i>spasm</i> —or <i>obstruction</i> , as — — — — —	HYPOCHONDRIAC AFFECTION	
	COLIC, or SPASMODIC PAINS }	
	JAUNDICE	
	GALL-STONES	
	GRAVEL	
	TYMPANY	
	COSTIVENESS	
	PILES, &c.	

III. Of

III. Of the Lymphatic Glands—or Cutaneous Ducts, arising from de- pravity of the Lymph— infection—or inactivity, as	RICKETS
	SCHIRRUS
	SCROPHULA
	TUBERCLES OF THE LUNGS?*
	OPHTHALMIA
	SCALD HEAD
	LEPROSY
	LUES VENEREA?*
	ULCERS
	ERUPTIONS, &c.

The above classes comprehend a great variety of chronic diseases, in which reason, experience, and analogy, seem to unite in bearing testimony to the propriety, and utility of this water. But its success will, I conceive, greatly depend on its being taken at an early period, and duly managed, particularly in cases of the more stubborn kind.

*Cases wherein supposed doubtful—or even improper—
Consequences of its abuse.*

It is proper to observe, that many of the above-mentioned diseases are often complicated with others that require different treatment, and which consequently must render the use of this water sometimes doubtful, at others totally repugnant to the principal intention of cure. Such in general are all nervous diseases, which rarely bear the repetition of cold purging salts with impunity.

* Here the Notes of Interrogation imply further Inquiry.

Dr. SMITH indeed mentions *one* instance of a species of palsey, wherein the Cheltenham water proved successful; but this affords but *one* exception to the general rule.* If through peculiar circumstances other instances should occur, it will be necessary to discriminate *such* circumstances accurately, before any inference can be drawn, either as to the *general*, or *partial* use of these waters in *nervous* diseases.

Another very important question arises—How far may these waters be used with safety; and a prospect of success, in incipient *tubercles* of the lungs, which if neglected at the beginning, too often terminate in *consumption*? This may deserve the attentive observation of the discerning part of the faculty, who alone are competent to the task of distinguishing tubercles in their *nascent* state, or of obviating the progress of that insidious malady, so often fatal to the youthful inhabitants of this island. The ill success that has hitherto attended the several remedies extolled under the pompous terms of *vulneraries*, *pectorals*, and *balsamics*, tacitly admonishes us to adopt other methods of treatment, and to form our indications of cure on more rational principles.

A mineral water which possesses the power of pervading the lymphatic system, and of disburthen-

* Observations on the Use and Abuse of Cheltenham Water. ing

ing obstructed glands in remote parts of the machine, by promoting an increased secretion from the intestinal glands, and that without heating, or weakening the frame, seems, of all others, the most likely to answer the intention. Now the Cheltenham water not only possesses these properties in an eminent degree, but has *actually* been found successful in discussing glandular tumours in other parts of the system, and therefore has every argument in its favour that analogy can suggest.

The small portion of iron contained in the water need not be dreaded on account of its supposed *heating* quality, which is effectually obviated by a large proportion of cooling salts sufficiently diluted ; and be it remembered, that the objection lies much stronger against the resinous gums, balsams, Peruvian bark, squills, and other *stimulants*, which often serve but to exasperate the symptoms, and yet continue to be daily exhibited in this disease, without fear or apprehension.

Where confirmed tubercles of the lungs have already advanced to suppuration, the case is become too desperate to admit of any permanent relief, from this, or perhaps any other remedy hitherto discovered. This water therefore is proposed not to *cure ulcerated* lungs, but to *prevent* the lungs from
ulcerating ;

ulcerating; not to *disperse inveterate tubercles*, but to *crop* them in the early bud.

To particularize the various circumstances, wherein the use of this water may be doubtful or improper; or to enumerate the symptoms which might seem to contra-indicate its operation, compared with that of other saline purgatives, would far exceed my present bounds.

It may be sufficient to observe in general, that wherever the nervous system has been much weakened, the vital powers greatly diminished, or the strength impaired by natural, or artificial discharges, or other debilitating causes; or finally, where evacuants depress the spirits, or irritate the nerves; it ought by no means to be administered as a *direct* purgative, nor even as an *alterative*, without the utmost circumspection. Neither ought the purgative course, in any case, to be continued for several weeks successively without some intermission. Much less should this water be ever wantonly drank, or unnecessarily, especially by healthy persons, (as certain ignorant rustics are wont to do without measure, or bounds) as if profuse purgation was a matter of indifference, or rather necessary to improve good health—a dangerous delusion!—The habitual use of purgatives, even

even of the milder sort, not only impoverishes the habit, but undermines all the powers of life; and finally, too often ushers in a long and dismal train of hypochondriacal or nervous symptoms!

Nor are instances wanting, as I have been informed, where impaired vision, or even a *Gutta Serena*, with other nervous symptoms of an alarming nature, have been certainly produced by such an improper *use*, or rather preposterous *abuse* of these waters!

Directions for drinking it with success.

The most suitable season for a course of the Cheltenham water, is undoubtedly during the summer months, namely, from the middle of May, till the latter end of September. In cases of exigency, it may be used at other times, though seldom perhaps with equal advantage.

With regard to preparatory means, internal medicines are seldom necessary; the water itself supplies its own proper *preparative*, and, if discreetly managed, supersedes the use of other evacuants. *Warm bathing*, indeed is often requisite previous to its use, in certain stubborn diseases of the glands, and particularly where they are attended with obstructed

obstructed perspiration, rigidity of the fibres, spasmodic strictures, cutaneous affections, &c.

In these, and various other instances of this kind, the celebrated WARM SPRINGS at BATH very *justly* bear the *pre-eminence*, and ought therefore to precede that of Cheltenham, or rather *supply* its place. The Bath waters are, moreover, much better provided with every necessary convenience for *general* or *partial* application. The Cheltenham water, in its turn, presents us with a very useful preparative for a course of the Bath waters, particularly in cases where saline purgatives *only* are required.

Early rising being conducive to health in general, and to the successful use of this water in particular, the invalids ought to repair to the spring at an early hour, and drink the water fresh at the fountain head, the instant it is poured into the glass, lest the aërial principles should exhale.

Admitting the importance of these subtle fluids, we may account for the material difference experienced between drinking the water fresh at the pump, and after it has stood exposed to the air, or been conveyed to a distance. For though it retains its purgative ingredients after the volatile parts have escaped, yet the exhilarating quality is lost;

lost; an entire decomposition takes place, and it no longer produces the same effects as when it is drank fresh, and replete with those active principles. Hence, we perceive the error of those patients, who, through indolence or inattention, content themselves with having the water brought to their lodgings in bottles, often very imperfectly corked:—A custom too prevalent, especially among people of fashion, who thus lose the main efficacy of the water, together with that exercise in the open air which is so highly conducive to its success!

When patients are accidentally detained at their lodgings through the inclemency of the weather, the water should be brought in a bottle with the cork downwards, and remain in that position till the moment it is used.

At the beginning of the course, it may be prudent, at least the two first days, to commence with the smallest sized glass, viz. a quarter of a pint at first rising in the morning, as a gentle laxative. If it produces no sensible effect within three hours, it then may be repeated. If this quantity fails of producing two easy motions, it may be increased the next day to half a pint.

Some drink with ease two or three glasses before breakfast; others cannot bear half this quantity without suffering great inconvenience from the coldness, and pressure of the water. In such cases, it will be much better to take small doses, at longer intervals: For instance, the first glass before breakfast; the second an hour after breakfast; and the third about eleven o'clock, walking or riding between each glass. Thus the whole may be conveniently over before noon, and yet admit of a pleasant airing in the country before dinner.

After the first week, the quantity may be increased to half a pint or upwards, three or four times a day, according to its operation, and the intention of the prescriber. When it passes off too slowly, a glass may be taken in the evening, or a quarter of an ounce of the neutral salt may be dissolved in a half pint glass of the water for the morning dose; drinking immediately after it a basin of warm tea or gruel, especially if the water occasion a sense of chillness, or flatulency in the stomach or bowels.

Some, with a view to obviate these inconveniences, heat the water over the fire, which, by dissipating its volatile parts, greatly diminishes its virtues, and instead of making it more palatable,

table, as Dr. RUTTY asserts, renders it abundantly more nauseous.

Others, with a similar intention, have recourse to tinctures, essences, or sundry aromatic seeds in form of comfits, or sugar-plumbs; when a glass of simple pepper-mint water, or even brisk exercise alone, would answer the intention much better, and that without perverting the operation of the water, palling the appetite, or injuring the digestive powers, which an habitual use of such remedies is extremely apt to do.

A course of this water may require from three to five weeks, or upwards, but not without suspending its use one day in each week, in order to give the system proper respite, and to prevent the water losing part of its efficacy through habit;* finally, it ought to be left off in the same gradual manner in which it was begun, using, for the space of two or three weeks after it, a more abstemious diet, and guarding against costiveness.

* Therefore His MAJESTY's Royal Command for shutting up the fountain on Sundays, whether considered in a *religious* or *medical* point of view, appears to be strictly proper; it is moreover founded on sound policy, being well calculated to accommodate the company with a plentiful supply of the water the ensuing week.

The propriety of the above caution will appear obvious, when it is considered, that large evacuations long pursued, and then suddenly discontinued, dispose the system to plethora and all its consequences, especially if a free course of living be imprudently indulged.

Hence perhaps may be explained the vertigo, head-ache, drowsiness, and other manifest symptoms of plenitude, which often succeed such improper conduct, and which have a manifest tendency to defeat the main intention of the whole preceding course.

Diet and Regimen.

Intemperance, or inattention to diet or regimen, may entirely frustrate the hopes of the patient and of the practitioner, in regard to the utility of this as well as other waters. Such are the immoderate use of gross animal food, the abuse of strong liquors, indolence, late hours, hot rooms, and sudden exposure to cold, particularly in the night season, or the drinking cold liquors after the body is heated by dancing, or other violent exercise.

The food, on the contrary, ought to be moderate in quantity, simple, easy of digestion, and nutritious.

tious. It should also be accompanied with a due proportion of farinaceous aliment, and esculent vegetables, many of which the soil of this country produces in great abundance, and in very high perfection.

For breakfast, cocoa or chocolate, with milk, and other light spoon-meats, are in general preferable to either tea or coffee.

At dinner, broths or soups, together with any sort of animal food or fresh fish that best agrees, may be eaten with moderation.—The drink may consist of good table beer, followed by a few glasses of generous wine.

Summer fruits, either before or after meals, are by no means objectionable, provided they are perfectly ripe, and eaten sparingly.

The exercise should consist chiefly of riding or walking, and should be used before meals, and regularly pursued during the whole course.

It is almost superfluous to add, that not only every kind of excess ought to be carefully avoided, but also intense study and application; for above all things, the mind ought to be kept tranquil, or

agreeably amused.* All unnecessary concern about business, or domestic affairs, must for a while be dismissed, and every cause of grief, anxiety, or inquietude, if possible, prevented:—A circumstance of the utmost importance to all persons labouring under inveterate diseases, who wish to reap real benefit from this, or indeed any other course of medicine.

Having thus attempted briefly to point out the general principles of the Cheltenham water, the diseases in which it is indicated, and the directions necessary to its use, I forbear descending to other particulars. The nature of the water being once understood, these will readily suggest themselves to the intelligent reader.

As no invariable rule in matters of this sort can be laid down, the discreet practitioner will vary the plan according to the operation of the water, the state of the disease, the constitution of the patient, and other circumstances.

* Respecting the Public Amusements, New Improvements, Natural Curiosities, Agreeable Rides, Extensive Prospects, appertaining to the place; see the new edition of A TOUR TO CHELTENHAM SPA, by SIMEON MOREAU, Esq; M. C. where the reader's curiosity will be abundantly gratified concerning all these particulars.

From due attention to the above cautions, he will also be enabled to determine whether the water ought to be used as a direct *purgative*, or only as an *alterative*; and finally, to provide for unseen accidents that may happen during the whole course.

To CONCLUDE:—Since the nature and qualities of mineral waters can only be ascertained by a series of experiments and observations, instituted on the spot, it were earnestly to be wished, that a NEW AND ACCURATE ANALYSIS OF SEA-WATER, and also OF OUR PRINCIPAL MINERAL SPRINGS, were undertaken BY AUTHORITY, as a matter of PUBLIC CONCERN; and that the Royal College of Physicians would adopt such measures, as to them might seem necessary, for carrying it into execution.

That, in the interim, the resident practitioners were requested to expedite the work, by preserving accurate journals of the principal cases committed to their care, candidly noting down the UNSUCCESSFUL, as well as the successful events. The result of such an inquiry, impartially conducted, would redound much to their honour, and afford the public more satisfactory information concerning mineral waters, than they have ever yet been favoured with.

It would also rescue our medicinal springs from the opprobrium of being frequented, as they now commonly are—on no better foundation, than that of fashion or caprice.

Some it would bring into notice, that are now but obscurely known; others it would strip of their borrowed plumes, by proving their ineffectacy, and by exposing the fabulous cures attributed to them by ignorance, self-interest, or superstition. Each would thus, in time, find its own proper level in the scale of merit. Their natural and chemical history would be completed;—their comparative virtues ascertained;—science enlightened;—and the practice of medicine improved.

Our medical practitioners would then no longer be at a loss concerning the nature and properties of the different mineral waters. Instead of placing, as heretofore, implicit confidence in the peremptory assertions of preceding writers, they would then be qualified to detect their errors—Instead of yielding, as at present, to the overwhelming influence of popular prejudice, they would then be enabled to assert their *own* judgment—Instead of hesitating in their choice concerning *this* or *that* spring, or recommending waters of opposite qualities indiscriminately, they would then, in

in the first instance, be competent to decide with propriety.

In a word—instead of dispatching their patients, as at present, in the random pursuit of *imaginary* virtues, they would then be enabled, at once, to direct them with precision to such as were *real*.





A P P E N D I X.

WATER—*Whether it be not essential to Air—and whether its component Parts be yet discovered.*

SINCE the preceding sheets were sent to the press, I find that, in consequence of some recent experiments, the ingenious Dr. PRIESTLEY is now convinced that water not only enters into the composition of *inflammable* air, but also into that of *vital* and *fixed* air, and is therefore probably the *basis* of every species of air.

He moreover delivers it as his opinion, that the existence of phlogiston, though doubted by some, yet remains firm and unshaken.—That *this* principle with water constitutes *inflammable* air, while a peculiar acid with water forms *vital* air.—That *this* acid o *vital* air (whatever it may be) is the basis of all other acids, and may be considered as the principle of *acidity*, while the *phlogiston* constitutes

tutes the *alkaline* quality of bodies.—But that no *aërisome* fluid can exist without *water*, which he finds essential to their composition.

If *air* then cannot be wholly divested of *water*, nor *water* of *air*, does it not follow, that *water* cannot be completely decomposed? and consequently that the late BRILLIANT DISCOVERY of *water* being composed of equal parts of inflammable and vital air (received with such universal avidity) must at last, though not without regret, be given up!

CHELTONHAM WATER—How far it may be imitated by Art—Attempt towards an Artificial Cheltenham-Water.

At a distance from the Spa, and where the natural water cannot be procured in its fresh and genuine state, the following *umble* imitation may probably prove not wholly unacceptable. It is not pretended *exactly* to resemble the former in taste and appearance, much less to supersede the necessity of drinking the *genuine* water at the *fountain-head*, whenever that can be complied with. Should it only be found, in some measure, to approach the real Cheltenham water, in its general operation and effects, it may be perhaps deemed no contemptible substitute in cases of emergency; which is all that is

is proposed, or indeed can be reasonably expected. As such then, where a saline chalybeate water is immediately wanted for extemporaneous use, I should incline to recommend the following form, which is easily prepared by any apothecary possessed of the glass apparatus for impregnating water with fixed air.*

	<i>Grains.</i>
Take pure Glauber and Epsom salts, of each	120
— of common salt	— — 6
— magnesia-alba	— — 3
— flowers of sulphur	— — 8
— clean iron filings	— — 5
— Spring water previously boiled, or rather distilled—2 quarts.	

Having put these several ingredients into the middle vessel of the above-mentioned apparatus, let the whole be impregnated with fixed air discharged from an effervescent mixture, composed of vitriolic acid with powdered chalk, or rather marble, according to the printed directions for preparing Pyrmont water.

* This elegant apparatus, invented by Dr. NOOTH, has been considerably improved by Mr. PARKER, in Fleet-street, London; and may be had at all the principal glass-warehouses, with printed directions.

The process may be expedited by agitating the vessel occasionally, and may be easily completed in two hours; when the water may be drawn off and passed through flannel, or a common strainer, into clean pint bottles; it will then be fit for use, and may be drank according to the directions already given concerning the real Cheltenham water.

The sulphur, if previously ground with *calcined magnesia*, will more readily yield the sulphureous impregnation; but if this quality should be required in a stronger degree, or equal to that of Harrowgate water, it may be readily accomplished, by only putting about a dram of *hepar sulphuris* (prepared from sulphur and quick lime in equal proportion) into the bottom vessel, along with the effervescent ingredients.

The phlogisticated air will be also thus in some measure supplied, and, if thought necessary, may be increased to any pitch, by agitating the water with common air in which a lighted match or candle has burnt out.

The selenite, being considered as wholly immaterial, is purposely omitted for reasons already assigned.*

* Exp. Inq. p. 80.

The Mephitic Alkaline Water.

This remedy was first introduced to our notice by that expert chemist the late Mr. BEWLEY, under the term Mephitic Julep. Having discovered fixed air to be an *acid* capable of neutralizing alkaline salts, he justly concluded that, by this union, water might be more strongly impregnated with this subtile acid than by any other means, and therefore proposed it to the faculty, as a compendious method of administering fixed air very copiously as an antiseptic remedy:—An object highly worthy our consideration in all putrid diseases; and yet, by some strange fatality, it has been almost wholly neglected!

To Mr. BENJAMIN COLBORNE it is owing, that our attention has lately been recalled to this elegant form of medicine, though with a very different intention.—To him we are indebted for the important discovery of its efficacy in those excruciating diseases—the stone and gravel. After long undergoing himself the severest tortures, without any prospect of relief from other remedies, he first experienced its happy effects in his own person, and afterwards recommended it to many of his fellow-sufferers, and with the like success. Since which, its reputation has very rapidly advanced, and it

now

now may perhaps be considered as one of the safest and most efficacious medicines hitherto discovered.

It comes, moreover, with this peculiar recommendation in its favour, that it is not, through motives of interest or pecuniary advantage, brought forward under the mysterious guise of a secret *nos-trum*; but the remedy is at once candidly divulged, and every circumstance laid open, together with the names and places of abode of many respectable characters, who have tried it with the happiest effect.

Method of preparing it.

As it is a matter so extremely *interesting* to the cause of humanity, it cannot be made too public; I shall therefore here subjoin the rules necessary to be observed in preparing it. As this, however, has been already done with great accuracy by the learned Dr. FALCONER, I shall adopt his words, as they stand in the printed narrative.*

“ The most convenient method (says he) of preparing the alkaline solution, is as follows. Put

* See his Appendix to Dr. DOBSON's Commentary on Fixed Air, new edition, p. 8.

" two ounces and a half troy weight, or, if troy weights are not at hand, two ounces and three quarters avoirdupois,† of dry salt of tartar into an open earthen vessel, and pour thereon five full quarts, wine measure, of the softest water, that is clean and limpid, that can be procured, and stir them well together with a clean piece of wood. After standing 24 hours, carefully decant, from any indissoluble residuum that may remain, as much as will fill the middle part of one of the glass machines for impregnating water with fixible air.‡ The alkaline liquor is then to be exposed to a stream of air, according to the directions commonly given for impregnating water§ with that fluid. When the alkaline solution has remained in this situation till the fixible air ceases

" † Two ounces and a half troy weight contain 1200 grains; two ounces and three quarters avoirdupois contain 1201 grains and a quarter of a grain.

" ‡ If the salt of tartar be good, and perfectly soluble in the water, every ounce measure of the alkaline solution should contain seven grains and a half of alkaline salt.

" § Those machines that have a contrivance for drawing off the water without separating the parts of the vessel are most convenient. The directions given with the machines sold by Mr. Parker in Fleet-street, will serve this purpose very well, save that the alkaline solution requires more of the effervescent materials, and a longer time to saturate it, than simple water.

" to rise, a fresh quantity of the fermenting materials should be put into the lower part of the machine, and the solution exposed to a second stream of air, and this process repeated four times.

" When the alkaline liquor shall have continued about 48 hours in this situation, it will be fit for use, and should then be carefully drawn off into perfectly clean bottles (pints are, I think, preferable) and closely corked up. The bottles should then be placed with their bottoms upwards* in a cool place; and with these precautions it will keep several weeks, and perhaps much longer, very good.

" The quantity of alkaline solution above directed to be mixed at the beginning of the foregoing directions, is judged to be sufficient to fill the glass machines of the common size twice over, without pouring off the liquor so deep as to hazard making the solution turbid, by stirring up the indissoluble residuum which is precipitated at the bottom of the vessel.†

" * A shelf with holes in it to put the necks of the bottles into, such as are commonly used for wine decanters, is convenient for this purpose.

" † If the alkaline solution, as above directed, should be found too irritating, it may be made with a smaller proportion of the salt.

" The water in which the alkali is dissolved,
 " should be as free of foreign impregnations as pos-
 " sible, as the alkali, by decomposing them, will
 " not only cloud the water, but form other combi-
 " nations, inconsistent, perhaps, with the effects to
 " be wished for from the remedy. The intention
 " therefore of mixing the salt of tartar with the
 " water the day before, and of the caution recom-
 " mended in pouring it off, is to allow time for any
 " precipitation occasioned by the mixture to settle,
 " as well as to separate the indissoluble parts of the
 " salt of tartar itself.

" Nor is less attention necessary in procuring the
 " salt of tartar pure and in perfection; and on that
 " account it should be got from such places only as
 " can be depended upon. When properly pre-
 " pared, the alkaline mephitic water should be
 " perfectly clear and rather sparkling, of an acidu-
 " lous taste, and totally free of that disagreeable
 " impression which alkaline salts make on the
 " tongue and throat.

" About eight ounces by measure appear, from
 " some of the cases, to have been taken thrice in
 " twenty-four hours, for a considerable time toge-
 " ther, and to have agreed well with the stomach,
 " appetite, and general health; but I apprehend

" most people will think this too large a quantity ;
 " and I believe, that for most cases, two-thirds
 " of a pint of the alkaline liquor in 24 hours may
 " suffice. Should the bulk of the separate doses*
 " be thought too large, the alkaline solution may
 " be made of double the strength ; in which case,
 " half the quantity will be enough.

" The times of taking three doses in the day
 " have been, I believe, pretty early in the morning,
 " about noon, and about six in the evening. If
 " twice a day, about noon and in the evening ; and
 " if once, which in many cases seems sufficient for
 " a preventative, about an hour and a half before
 " dinner. Common prudence dictates, that such
 " a remedy should be taken at such times as the
 " stomach is least likely to be loaded with victuals.

" I do not find, from observation or inquiry, that
 " a rigid adherence to any particular regimen of
 " diet is necessary, farther than the usual pruden-
 " tial cautions of moderation and temperance.

" The Reverend Dr. Cooper has made use of
 " fruit, wine, and other things subject to aescency,
 " during the time of his taking the solution ; yet
 " no person, as will appear by his very judicious

" * See Dr. Cooper's Case.

" account,

" account, has received greater benefit. I however
 " think it would be adviseable to abstain from
 " acids, and from such things as are subject to
 " become acescent, for some time before, and also
 " after the time of taking the doses of the alka-
 " line solution.

" I do not find either from my own observation,
 " or from the accounts of others, that any very
 " perceptible effects, save that most to be wished,
 " the abatement of the troublesome symptoms,
 " followed the taking this remedy. I have in-
 " quired of a very sensible person of this city, who
 " has taken the solution in the largest quantity of
 " any that I have known; and he assures me, that
 " he found no effect from it, save that of gently
 " opening the body.

" Mr. Bewly speaks of a dose of it that he took
 " affecting the head (with vertigo I suppose) and
 " proving a pretty strong diuretic. But no such
 " consequences have been generally observed by
 " those persons of whom I have had an opportu-
 " nity of inquiring. The person before referred
 " to, informed me, that though it kept the body
 " gently open, it had no effect in increasing the
 " quantity of urine. Mr. Bewly's dose was indeed
 " large, he having taken, at one dose, such a quan-

" tity of the alkaline solution as contained 24
 " ounces by measure of fixible air; whereas the
 " quantity of air taken at a time, in a dose of the
 " solution above directed, is not calculated to
 " exceed 15 ounces; but this was repeated three
 " times a day, and no such effect observed. With
 " respect to the diuretic quality, it is well known
 " that the expectation of such an effect from any
 " thing we take, will often prove a very powerful
 " means of producing it.

" Should it prove cold or flatulent to the sto-
 " mach, as I have myself known it to do, though
 " I believe that rarely happens, a small portion of
 " spirits, as rum or brandy,* or any of the spiri-
 " tuous waters or tinctures, may be used without
 " any diminution of its good effects. A tea spoon-
 " ful of rum is mentioned to be taken with each
 " dose of the solution, in one of the cases subjoined,
 " and I have myself directed a small quantity of
 " tincture of cardamoms and of compound spirit
 " of lavender, with evident advantage. Mr. Col-
 " borne has found hot milk, in the proportion of
 " about one-fourth to that of the alkaline solution,
 " to be a very grateful addition, especially in cold
 " weather, and what tended much to reconcile it
 " to the stomach, and this without impairing in
 " the least its good qualities."

* See Dr. Cooper's Case.

" The

The alkaline solution might be yet more strongly impregnated with fixed air, and its virtues perhaps proportionably increased, were the water made use of previously divested of its atmospheric air, either by boiling or distillation. Might not this therefore be suggested as a material improvement in the process?

As to its general operation, it is said to act as a mild laxative, without exerting any evident diuretic power. Here, however, I must observe, that in every case, in which I have yet tried it, it *constantly* and *uniformly* discovered *diuretic* effects; and water impregnated with fixed air *alone*, is known to act as a diuretic, and remarkably so when combined with salt of tartar even in its simple state.

The mephitic water is not only found more efficacious than fixed air alone, but also possesses the singular property of preventing the urine of gravelly subjects from depositing any sand or earthy sediment, and at the same time corrects the acrimony of the urine, and thereby assuages pain, and obviates the return of paroxysm.

The alkali in this preparation being neutralized by the *aërial acid*, and therefore rendered perfectly mild and innocent, is doubtless, in point of safety, infinitely

infinitely superior to the caustic alkaline ley, and perhaps not inferior as a solvent. The copious earthy sediment which the urine deposits during a course of the soap ley, and which is triumphantly held forth by its advocates as an indubitable proof of its *solvent* power, is, I conceive, a mere deception. For this sediment, instead of demonstrating its action on the stone itself, only proves that, as a caustic, it abrades the vessels through which it passes, and as an alkali, naturally precipitates from the urine the terrene particles.

The transient relief from pain occasioned by it may perhaps be explained from its overpowering, for a while, the morbid stimulus produced by the stone, and rendering the body less sensible of the irritation. Besides, the mephitic alkaline water yields superior relief, without producing the smallest appearance of earthy sediment in the urine; but how far it may at length be found a *real solvent* of the stone in the kidneys or bladder, time only can determine.

The human calculus, according to the analysis of the accurate Bergman, consists of calcarious earth, intimately united with the saccharine acid, and a portion of fixed air, which union, agreeably to the laws of chemical attraction, cannot be dissolved

solved by an alkali, either mild, or caustic, because the saccharine acid unfortunately prefers a calcareous earth to either of them.

How far the united force of an alkali, supersaturated with fixed air, may be able to accomplish this great *desideratum*, by means of double elective attraction, I will not venture to decide. Thus much however is known by experiment, that tho' calcarious earth, with its *ordinary* proportion of fixed air, is insoluble in water, yet when an *extraordinary* quantity is added, it is rendered easy of solution in an aqueous menstruum.

Hence perhaps it is, that the present remedy, by superadding this necessary proportion of fixed air, increases the power of the menstruum, and thereby prevents the deposition of earthy sediment in the urine. But be this as it may, human calculi have been found not only eroded, but considerably diminished in their weight, by being immersed several hours in the mephitic solution;* which seems to demonstrate, that this circumstance actually takes place, at least, *out* of the body.

The alkali in the mephitic water acquires double the proportion of fixed air contained in it previous

* Appendix to Dr. Dobson's Commentary on Fixed Air,
p. 94, 95.

to the impregnation, and may therefore spare the necessary quantity for dissolving the calcarious earth, and consequently may thus be enabled to produce the effect just mentioned. Hence perhaps may be also explained the powerful effect of the Caroline waters in nephritic cases.

As the mephitic solution so powerfully corrects the acrimony of the urine,—and has moreover, I apprehend, a powerful *sedative* quality, it may, independently of its supposed solvent power, prove also very beneficial in mitigating the severe pains occasioned by inveterate ulcers, or even cancerous affections of the urinary passages. And therefore, by further inquiry, may possibly be found applicable to the important purposes of alleviating human misery in a variety of forms, and of administering ease and comfort, where these blessings were the least expected.

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